PG-40 Probability Models

- PG-40 has three models
  - All models are Random Variable aggregates.
  - Models can be identified by their fundamental mathematical equations.

PG-40 Probability Models

- Fundamental Equations:
- Level 1:
  - $Et = Eg + Ep$ [reference Sillars 1.1]
  - $V10th = Et$. (reference Sillars 1.2)
  - $V90th = \beta V10th$ (reference Sillars 1.3)
- Develop one for each SCC and sublevels as appropriate

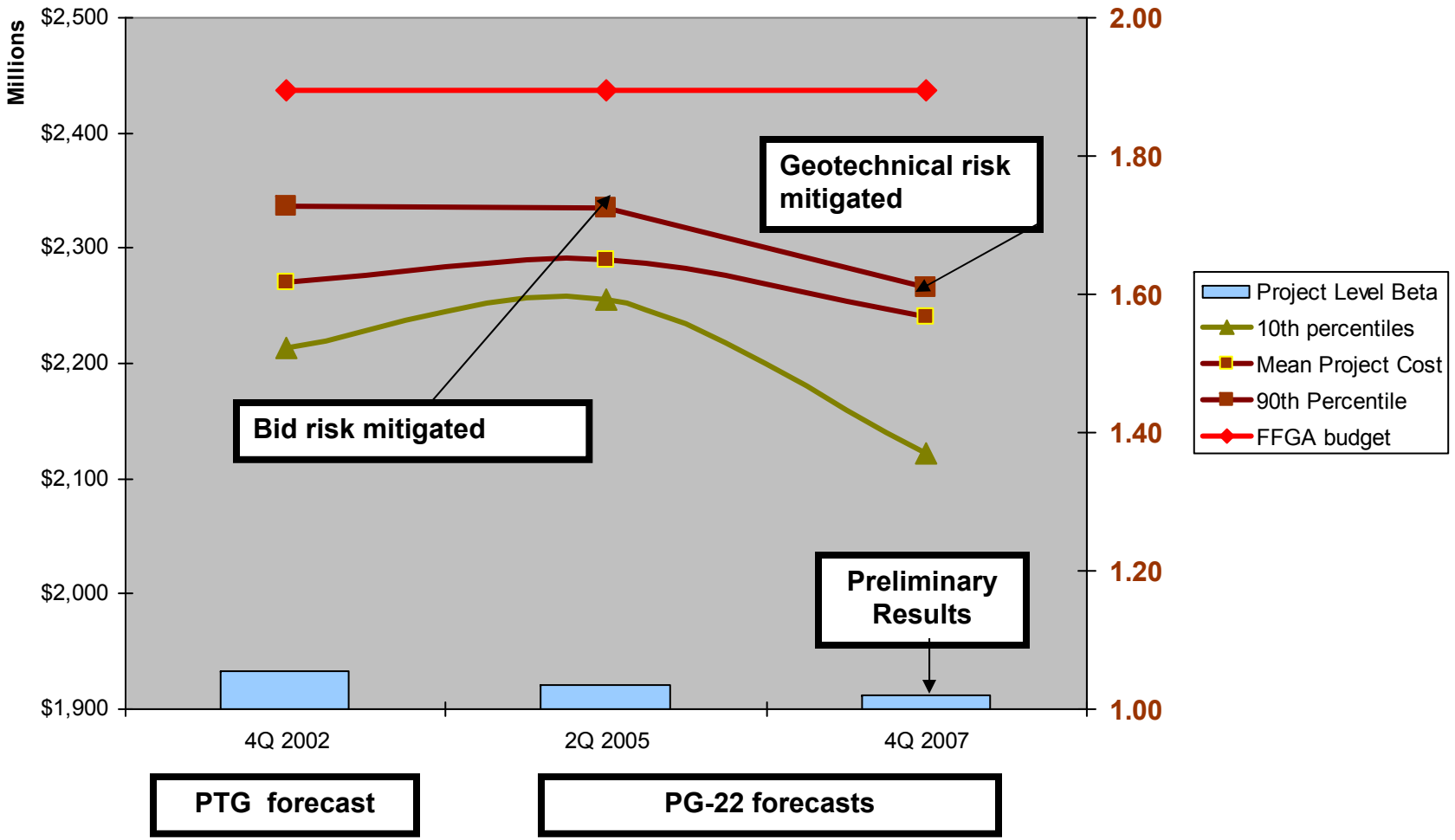
PG-40 Probability Models

- Fundamental Equations:
- Level 2:
  - *Et* = *Eg* +*Ep* [reference Sillars 1.1]
  - Develop a set of discrete estimates with a sample mean and sigma that is mapped to the population mean and sigma (triangular, etc.)
- Develop one for each SCC and sublevels as appropriate

PG-40 Probability Models

- Fundamental Equations:
- Level 3:
  - Develop 2 sets of data: budget base and enumerative risk list (risk register).
  - Develop Risk register as a set of discrete random variable fragments.
  - Sum fragments and develop variance with the base.

Seattle Central Link
Project Risk versus Time



Seattle Central Link
Project Risk versus Time

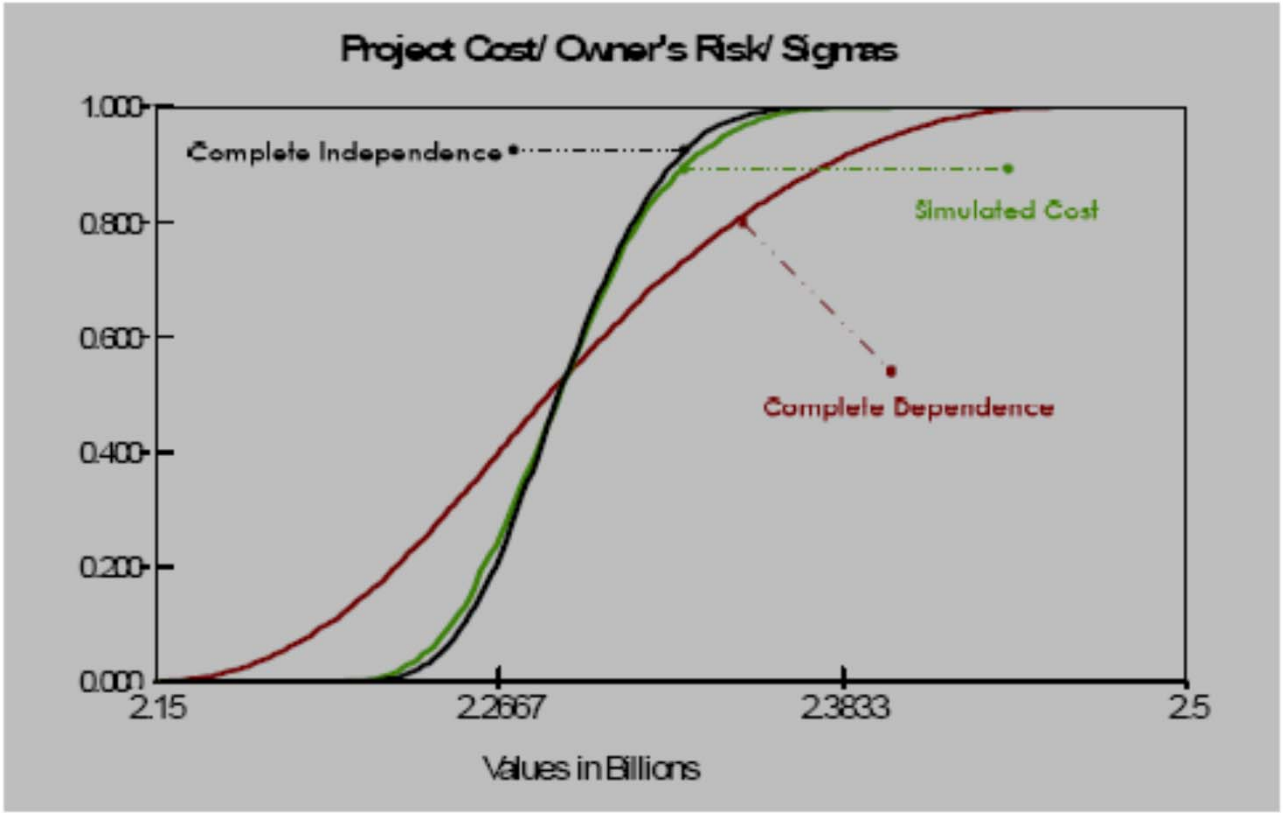
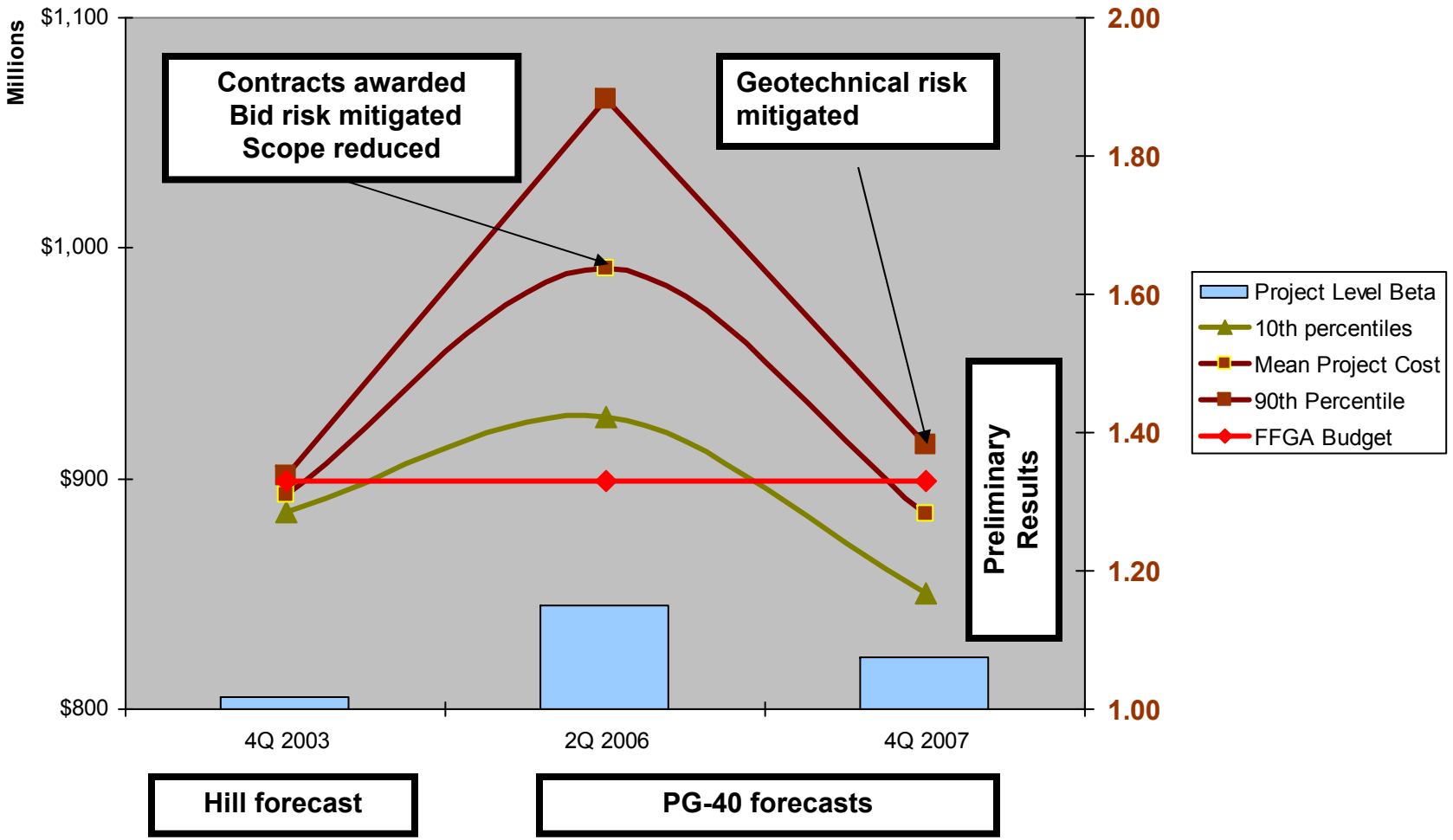


Figure 7-12 Sigma Analysis/ Project Cost/ Owner's Risk

PG-22 forecast in 2005

LACMTA ESGL
Project Risk versus Time



PG-22 Risk Model

PROBABILISTIC, RISK-BASED, INTEGRATED COST AND SCHEDULE APPROACH

- Starting with the project team's latest approved plan, confirm the "base" project scope, delivery strategy, and cost and schedule estimates.
- **The "base" is the planned project with no problems or opportunities, exclusive of contingency and bias.**

(Source Golder paper for Project Management Institute, Spring 2006) page 3

PG-22 Risk Model

PROBABILISTIC, RISK-BASED, INTEGRATED COST AND SCHEDULE APPROACH

- The sequence of all major project activities (both preconstruction and construction) is documented in a "flow chart," along with the related "base" unescalated costs, durations, and escalation rates for each activity; significant uncertainties and correlations among these factors are included.
- This forms the basis for a simplified but useful cost-loaded schedule model, which allows for determination of escalation and cash flow among other things (e.g., appropriately considering work windows, resource constraints, contingency plans).

(Source Golder paper for Project Management Institute, Spring 2006), page 3

PG-22 Risk Model

PROBABILISTIC, RISK-BASED, INTEGRATED COST AND SCHEDULE APPROACH

- Identify a comprehensive and non-overlapping set of potential "risk" and "opportunity“ events that could occur and alter the project "base," potentially leading to significant cost and schedule changes.
- Again, the level of detail (this time in terms of the number of risks) is flexible.

(Source Golder paper for Project Management Institute, Spring 2006), page 4

PG-22 Risk Model

PROBABILISTIC, RISK-BASED, INTEGRATED COST AND SCHEDULE APPROACH

- Combine the "base" and "risk" factor assessments to quantify uncertainty in the ultimate project cost (both unescalated and escalated) and schedule, and to determine the sensitivity of that cost and schedule to those factors.

(Source Golder paper for Project Management Institute, Spring 2006), page 4

PG-22 Risk Model

PROBABILISTIC, RISK-BASED, INTEGRATED COST AND SCHEDULE APPROACH

"Base + Risk"

- The approach quantifies uncertainty in project cost and schedule using a "base + risk" approach.
- The base + risk approach essentially replaces the conservative estimate from the traditional estimating approach with a "base" component, and replaces contingency from the traditional approach with a "risk" component (Figure 2).

- The base + risk approach then quantifies uncertainty in project cost and schedule as a function of:
  - the sequence of all project activities;
  - base activity costs, durations and escalation rates, with
  - associated uncertainty; and corresponding risks and opportunities.

(Source Golder paper for Project Management Institute, Spring 2006), page 6

PG-22 Risk Model

PROBABILISTIC, RISK-BASED, INTEGRATED COST AND SCHEDULE APPROACH

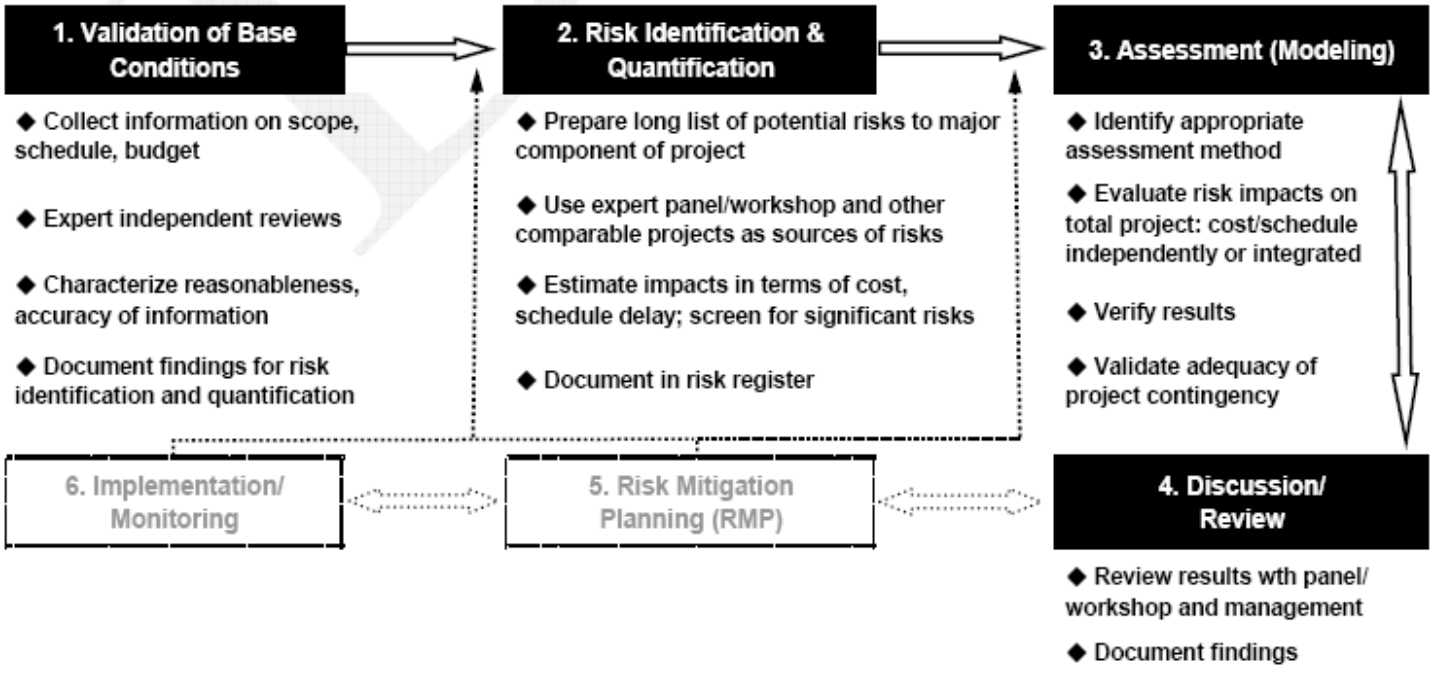
"Base + Risk"

- The base represents the complete, planned project if the project goes as planned (i.e., the assumptions made for the estimate are correct), which generally means without contingency, conservatism (to the extent possible), and float.
- Significant uncertainties within the base assumptions are included, as are correlations among uncertain base activity costs and durations ("base factors"). Risk and opportunity events represent potential deviations from the base assumptions (i.e., that the planned project may not go as planned). A comprehensive, non-overlapping
- set of risk and opportunity events is defined consistent with the base. Hence, an
- optimistic base would be complemented by a larger risk component, while a smaller risk
- component would accompany a more-realistic base. Risk is defined as probable loss, in terms of
- the combination of additional costs and/or durations to affected activities and the corresponding
- likelihood of occurrence. Opportunity is defined as probable benefit, in terms of reduced cost
- and/or duration and the corresponding likelihood of occurrence. Significant correlations among
- risk and opportunity events are included as appropriate. The base is combined with risk and
- opportunity through Monte Carlo simulation to quantify uncertainty in cost and schedule.

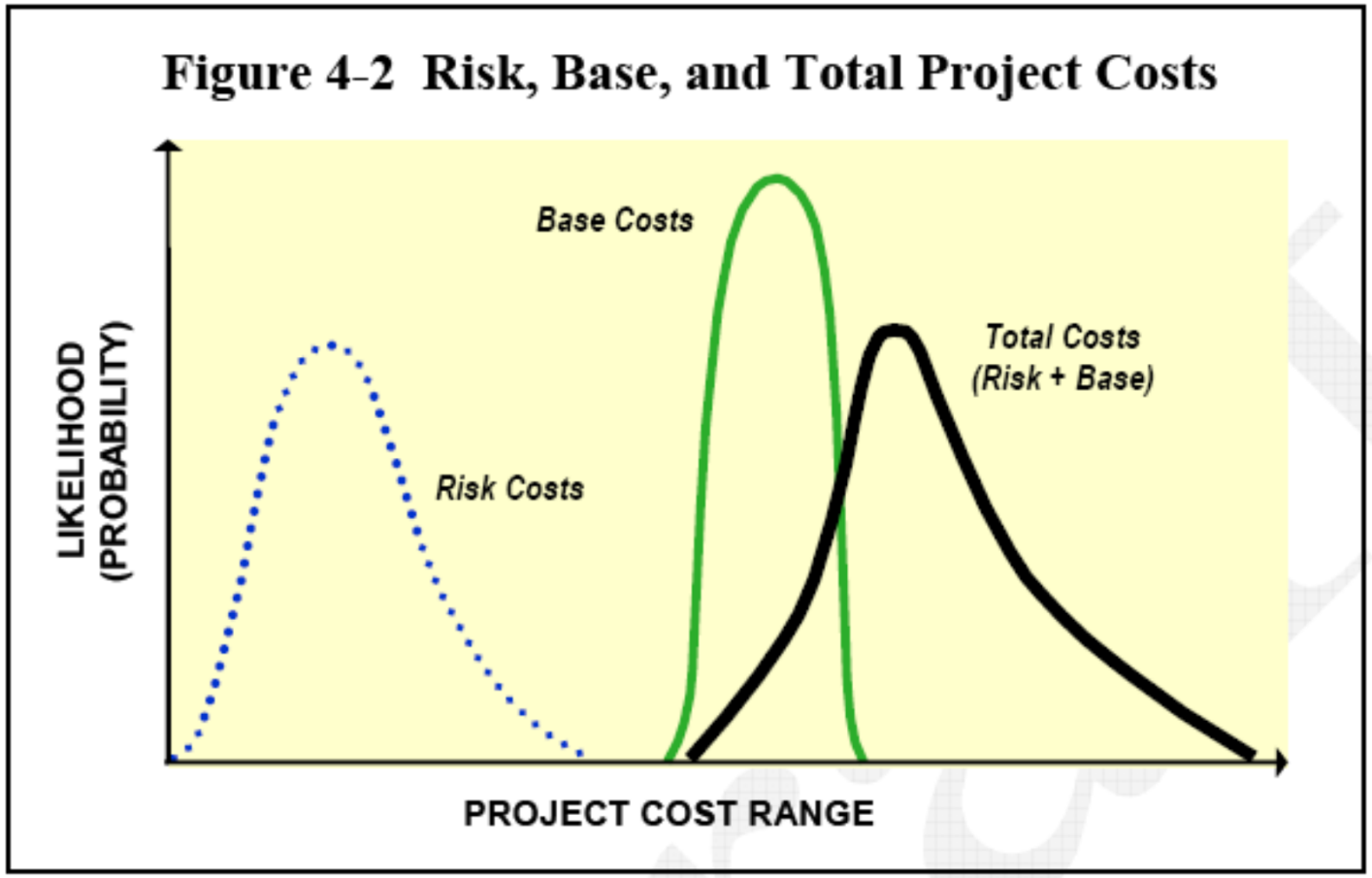
(Source Golder paper for Project Management Institute, Spring 2006), page 6

PG-22 Risk Model

Figure 4-1 Risk Assessment



PG-22 Risk Model



PG-22 Risk Model

4.3.3.1 Probability Basics [from 2004 white paper]

Probability is about the study of uncertainty. Theory of probability provides a

methodology for quantifying the likelihoods of various random events. **Probability of an *event*** is expressed with a positive number between 0 and 1. For event Esub J , P[E sub Ji] denotes the probability of event E subj and we have:

1≥P[Ei] ≥ 0 Eq. 4-2, page 37

Also, total probability of all elementary outcomes is 1.0, *i.e.,*

P(A) + P(B) + P(C) + P(D) = 1 Eq. 4-3

In Eq. 4-3, A, B, C, and D are probabilistic events that collectively define all the possibilities. Their total probability adds up to 1.0.

PG-22 Risk Model

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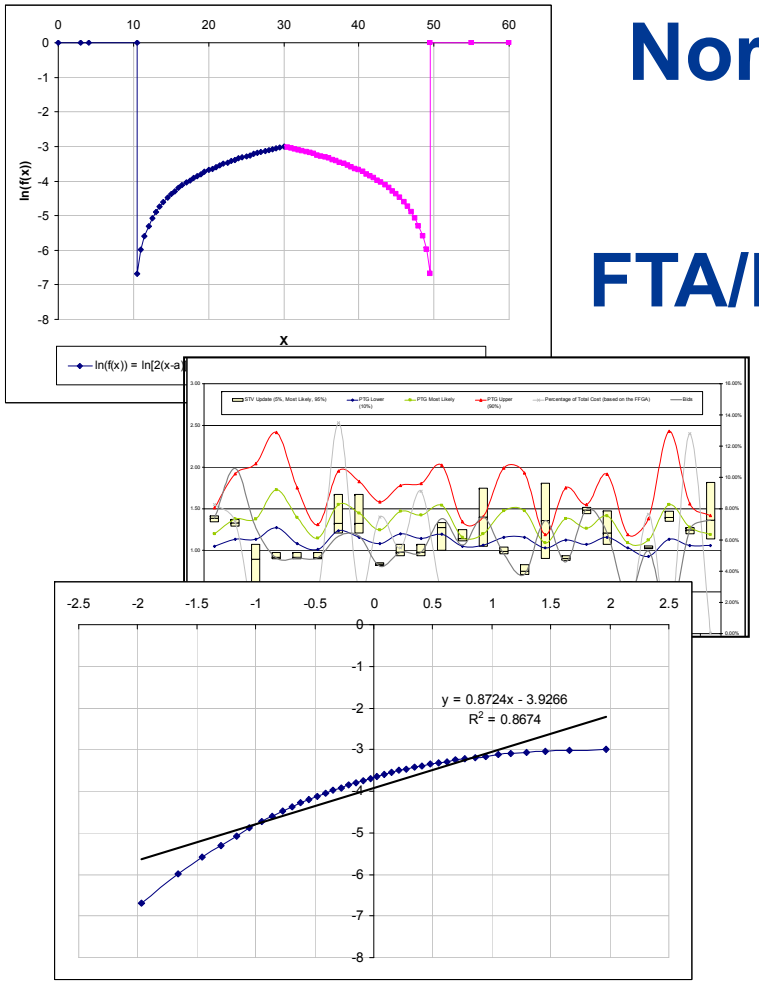

Northstar Risk Assessment

FTA/PMO Contractor Workshop

April 26 - 27, 2006

by

Behruz Paschai
Dan Reich
Jacobs

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Risk Analysis

- Level 1 risk analysis –

  "Top-Down / Management Baseline"
  - based on past experience
  - least amount of input
  - results available in a short timeframe
  - shown good performance in the past
  - management baseline tool for FTA
  - assume full correlation within SCC items only
  - prior to the Grantee mitigation workshop

Risk Analysis

- Level 2 risk analysis –
  "Top-Down / Target Variance"
  - based on cost breakdown
  - more detailed entries compared to Level 1
  - mitigation progress monitoring
  - testing different mitigation scenarios
  - define internal and external correlation matrices
  - prior to the Grantee mitigation workshop

Risk Analysis

- Level 3 risk analysis –

  "Bottom-Up / Risk Register"

  - identifying high ranking risks
  - define correlation matrices
  - not a suitable management base-line monitoring tool
  - provide input to Level 2 risk analysis
  - prior to the Grantee mitigation workshop

The β Factor

- Utilized in risk analysis levels 1 and 2
- $C_p(i,j)$ = p^{th} %-ile cost for SCC item i, sub-item j
- $C_{90}(i,j) = \beta \times C_{10}(i,j)$
- β defined based on past program experience
- Assists in establishing a robust 10-90 range

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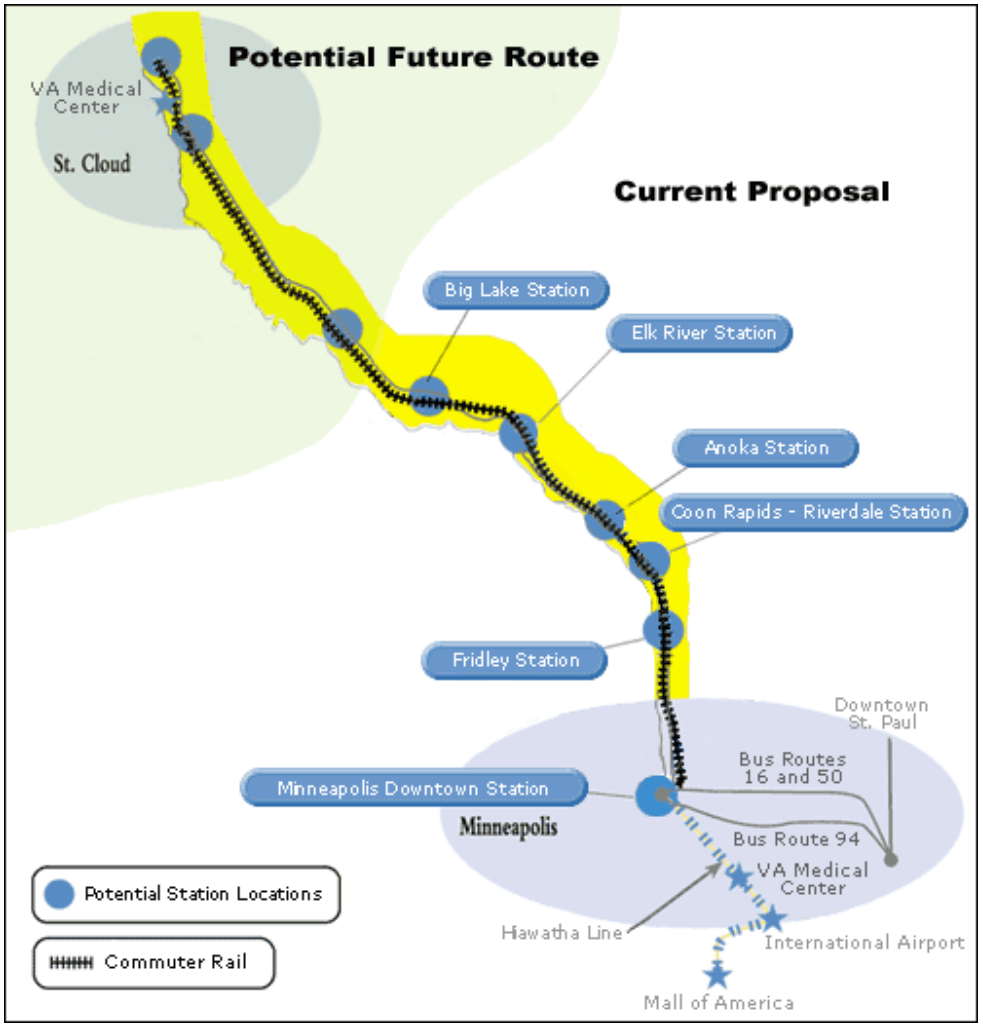
Northstar Project Limits



Source: www.northstartrain.org

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Risk Analysis - Level 1

1. What is the cost range that needs to be managed?
2. _____
3. _____

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Level 1 – Step 1

Get All Sigmas

		MNDot Budget	Allocated Contingency	Adjustments
	SCC10-Guideways & Track			
10.01	Guideway: At-grade exclusive right-of-way	$ 0.001		$ -
10.02	Guideway: At-grade semi-exclusive (allows cross-traffic)	$ 0.001		$ -
10.03	Guideway: At-grade in mixed traffic	$ 0.001		$ -
10.04	Guideway: Aerial structure	$ 8,947.66	$ 585.00	$ -
10.05	Guideway: Built-up fill	$ 6,309.75	$ 413.00	$ -
10.06	Guideway: Underground cut & cover	$ 0.001		$ -
10.07	Guideway: Underground tunnel	$ 0.001		$ -
10.08	Guideway: Retained cut or fill	$ 0.001		$ -
10.09	Track: Direct fixation	$ 0.001		$ -
10.10	Track: Embedded	$ 1,110.39	$ 73.00	$ -
10.11	Track: Ballasted	$ 11,644.86	$ 762.00	$ 1,350.00
10.12	Track: Special (switches, turnouts)	$ 11,316.90	$ 740.00	$ 1,350.00
10.13	Track: Vibration and noise dampening	$ 0.001		$ -
	Contingency	$ 2,573.00		
	Total	$ 39,329.57		

Get SCC10 Sigmas

10%	Factor	90%	Mean	Std Dev
$ 0.00	1.01	$ 0.00	$ 0.00	$ 0.00
$ 0.00	1.01	$ 0.00	$ 0.00	$ 0.00
$ 0.00	1.01	$ 0.00	$ 0.00	$ 0.00
$ 8,362.66	1.81	$ 15,129.69	$ 11,553.30	$ 2,708.59
$ 5,896.75	2.00	$ 11,793.50	$ 8,649.85	$ 2,382.63
$ 0.00	1.01	$ 0.00	$ 0.00	$ 0.00
$ 0.00	1.01	$ 0.00	$ 0.00	$ 0.00
$ 0.00	1.01	$ 0.00	$ 0.00	$ 0.00
$ 0.00	1.01	$ 0.00	$ 0.00	$ 0.00
$ 1,037.39	1.75	$ 1,815.43	$ 1,405.44	$ 310.55
$ 12,232.86	2.00	$ 24,465.72	$ 17,944.19	$ 4,942.79
$ 11,926.90	2.00	$ 23,853.80	$ 17,495.38	$ 4,819.16
$ 0.00	1.01	$ 0.00	$ 0.00	$ 0.00
				$ 7,795.21
$ 39,456.57		$ 77,058.15	$ 57,048.17	$ 15,163.73

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Level 1 – Step 1

Risk Analysis - Level 2

1 _____

2 **What are the mitigation scenarios, progress monitoring?**

3 _____

Level 2 - Step 1a

- Cost estimate breakdown
  - estimate source
    - →unit pricing
      - > design quantity vs estimated quantity
    - →CER
    - →Lump Sum/Allowance
    - →Unknown

Level 2 - Step 1a

- Cost estimate breakdown
  - source document
    - →design documents
    - →design report
    - →specifications
    - →undefined scope

Level 2 - Step 1a

	Percent in Category	Unit Pricing			
		Design Quantity	0%	Estimated Quantity	Total
60.01 Purchase or lease of real estate	0.00%	$0	0.00%	$0	$0
design documents - (0,0,0)/ (0,0,0)/(0,0)/(1,0)/(0,0)	0.00%	$0	0.00%	$0	0.00%
design report - (0,0,0)/(0,0,0)/(0,0)/(1,0)/(0,0)	0.00%	$0	0.00%	$0	0.00%
specifications - (0,0,0)/(0,0,0)/(0,0)/(1,0)/(0,0)		$0	0.00%	$0	0.00%
Undefined Scope - (0,0,0)/(0,0,0),(/(0,0)/(1,1)/(0,0)		$0	0.00%	$0	0.00%
			0%		0.00%
60.02 Relocation of existing households and businesses	0.00%	$0	0.00%	$0	$0
design documents - (0,0,0)/ (0,0,0)/(0,0)/(0,0)/(0,0)	0.00%	$0	0.00%	$0	0.00%
design report - (0,0,0)/(0,0,0)/(0,0)/(0,0)/(0,0)	0.00%	$0	0.00%	$0	0.00%
specifications - (0,0,0)/(0,0,0)/(0,0)/(0,0)/(0,0)		$0	0.00%	$0	0.00%
Undefined Scope - (0,0,0)/(0,0,0),(/(0,0)/(0,0)/(0,0)		$0	0.00%	$0	0.00%
					0.00%
Total		$0 0.00%		$0 0.00%	$0 0.00%

Total from design documents	$0	$0
Total from design reports	$0	$0
Total from specifications	$0	$0
Total from undefined scope	$0	$0

CER		Lump Sum / Allowance		Unknowns		Total	
	0%		100%		0%		
$0	0.00%	$7,530,000	100.00%	$0	0.00%	$7,530,000	
$0	0.00%	$0	0.00%	$0	0.00%	$0	0.00%
$0	0.00%	$0	0.00%	$0	0.00%	$0	0.00%
$0	0.00%	$0	0.00%	$0	0.00%	$0	0.00%
$0	0.00%	$7,530,000	100.00%	$0	0.00%	$7,530,000	100.00%
	0%		0%		0%		
$0	0.00%	$0	0.00%	$0	0.00%	$0	
$0	0.00%	$0	0.00%	$0	0.00%	$0	0.00%
$0	0.00%	$0	0.00%	$0	0.00%	$0	0.00%
$0	0.00%	$0	0.00%	$0	0.00%	$0	0.00%
$0	0.00%	$0	0.00%	$0	0.00%	$0	0.00%
$0 0.00%		$7,530,000 100.00%		$0 0.00%		$7,530,000 100.0%	

$0		$0		$0	$0	0.00%
$0		$0		$0	$0	0.00%
$0		$0		$0	$0	0.00%
$0		$7,530,000		$0	$7,530,000	100.00%
					$7,530,000	100.00%

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Level 2 - Step 1b

- Definition of βs
  - more uncertainty means larger β
  - smallest β belongs to items which:
    - → have unit pricing
    - → have unit quantity
    - → exist in design documents
  - largest β belongs to items which:
    - → have unknown source
    - → have undefined scope

Level 2 - Step 1b

	Unit Pricing		
	Design Quantity	Estimated Quantity	CER
60.01 Purchase or lease of real estate	**$0**	**$0**	**$0**
design documents - (0,0,0)/ (0,0,0)/(0,0)/(1,0)/(0,0)	**1.30**	1.40	1.50
design report - (0,0,0)/(0,0,0)/(0,0)/(1,0)/(0,0)	1.40	1.50	1.60
specifications - (0,0,0)/(0,0,0)/(0,0)/(1,0)/(0,0)	1.50	1.60	1.70
Undefined Scope - (0,0,0)/(0,0,0),(/(0,0)/(1,1)/(0,0)	1.60	1.70	1.80
60.02 Relocation of existing households and businesses	**$0**	**$0**	**$0**
design documents - (0,0,0)/ (0,0,0)/(0,0)/(0,0)/(0,0)	**1.30**	1.40	1.50
design report - (0,0,0)/(0,0,0)/(0,0)/(0,0)/(0,0)	1.40	1.50	1.60
specifications - (0,0,0)/(0,0,0)/(0,0)/(0,0)/(0,0)	1.50	1.60	1.70
Undefined Scope - (0,0,0)/(0,0,0),(/(0,0)/(0,0)/(0,0)	1.60	1.70	1.80

Lump Sum Allowance	Unknowns	Total
$7,530,000	**$0**	**$7,530,000**
1.60	1.70	0.00
1.70	1.80	0.00
1.80	1.90	0.00
1.90	2.00	1.90
$0	**$0**	**$0**
1.60	1.70	0.00
1.70	1.80	0.00
1.80	1.90	0.00
1.90	2.00	0.00

Level 2 - Step 2a

- Definition of correlation matrices
  - internal correlation
    - →within SCC sub-items
    - →among SCC sub-items
  - external correlation
    - → among SCC items

Level 2 - Step 2a

SCC Item External Correlation	10 GUIDEWAY & TRACK ELEMENTS (route miles)	20 STATIONS, STOPS, TERMINALS, INTERMODAL (number)	30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	40 SITEWORK & SPECIAL CONDITIONS	50 SYSTEMS
10 GUIDEWAY & TRACK ELEMENTS (route miles)	1.00	0.85	0.85	0.85	0.85
20 STATIONS, STOPS, TERMINALS, INTERMODAL (number)	0.85	1.00	0.85	0.85	0.85
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	0.85	0.85	1.00	0.85	0.85
40 SITEWORK & SPECIAL CONDITIONS	0.85	0.85	0.85	1.00	0.85
50 SYSTEMS	0.85	0.85	0.85	0.85	1.00

SCC Sub-Item Internal Correlation	Internal Correlation			
	design documents	design report	specifications	Undefined Scope
design documents	1.00	0.9	0.75	0.65
design report	0.9	1.00	0.9	0.75
specifications	0.75	0.9	1.00	0.9
Undefined Scope	0.65	0.75	0.9	1.00

Level 2 - Step 2b

	COST ITEM	Estimate	10% *minus* Estimate	10%
	60.01 Purchase or lease of real estate			
1	design documents - (0,0,0)/ (0,0,0)/(0,0)/(1,0)/(0,0)	$0	$0	$0
2	design report - (0,0,0)/(0,0,0)/(0,0)/(1,0)/(0,0)	$0	$0	$0
3	specifications - (0,0,0)/(0,0,0)/(0,0)/(1,0)/(0,0)	$0	$0	$0
4	Undefined Scope - (0,0,0)/(0,0,0),(/(0,0)/(1,1)/(0,0)	$7,530,000	$0	$7,530,000
	Total	7,530,000	0	7,530,000
	60.02 Relocation of existing households and businesses			
1	design documents - (0,0,0)/ (0,0,0)/(0,0)/(0,0)/(0,0)	$0	$0	$0
2	design report - (0,0,0)/(0,0,0)/(0,0)/(0,0)/(0,0)	$0	$0	$0
3	specifications - (0,0,0)/(0,0,0)/(0,0)/(0,0)/(0,0)	$0	$0	$0
4	Undefined Scope - (0,0,0)/(0,0,0),(/(0,0)/(0,0)/(0,0)	$0	$0	$0
	Total	0	0	0
	Unallocated Cont			

BETA	90%	Mu	Sigma	Mean	Std Dev
0.00	$0	0.00	0.00	$1.00	$0.00
0.00	$0	0.00	0.00	$1.00	$0.00
0.00	$0	0.00	0.00	$1.00	$0.00
1.90	$14,307,000	16.16	0.25	$10,709,992.98	$2,724,605.10
	14,307,000	16.16		10,709,995.98	2,724,605.10
0.00	$0	0.00	0.00	$1.00	$0.00
0.00	$0	0.00	0.00	$1.00	$0.00
0.00	$0	0.00	0.00	$1.00	$0.00
0.00	$0	0.00	0.00	$1.00	$0.00
	0	0.00		4.00	0.00

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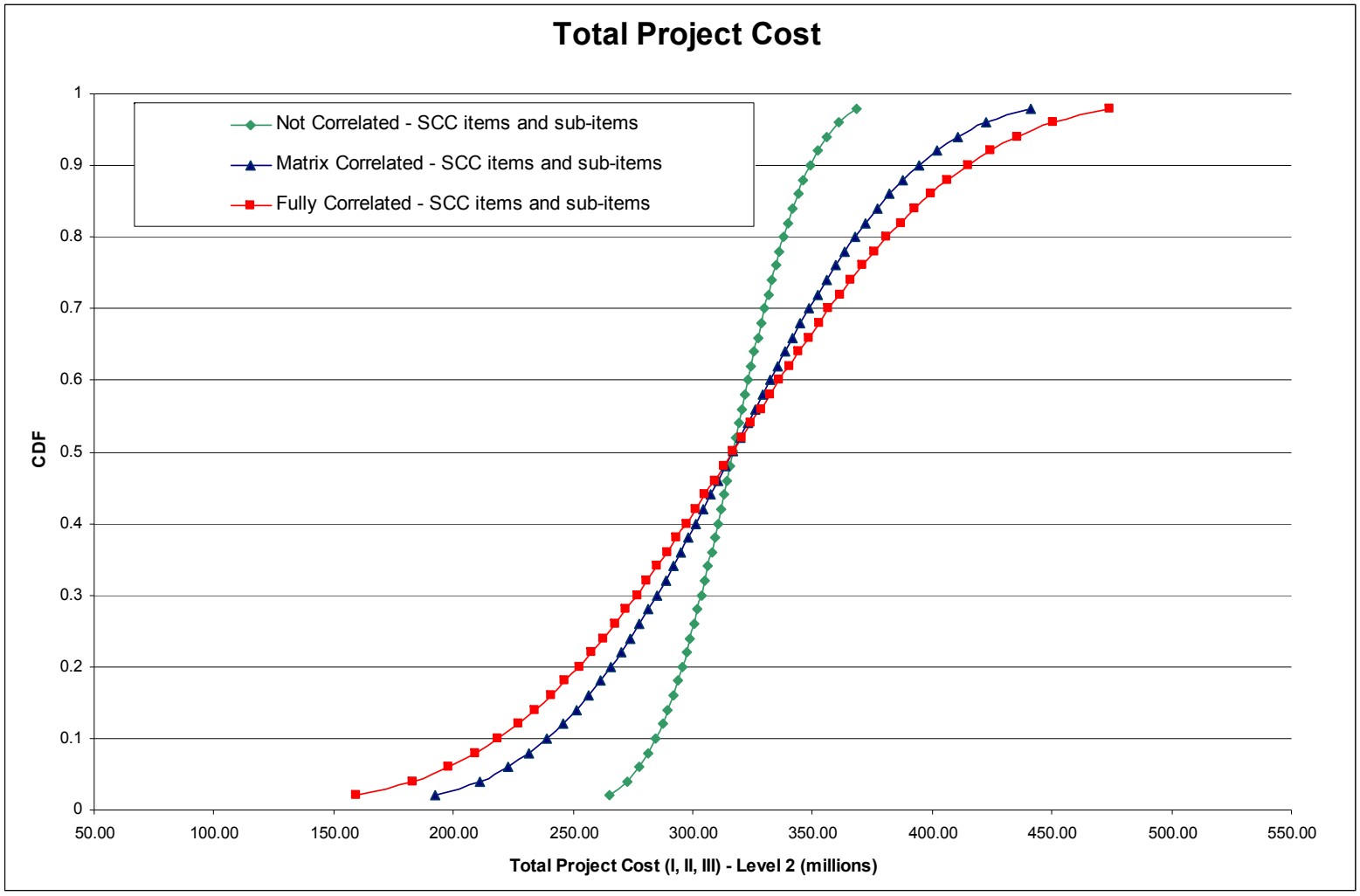
Level 2 - Summary



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Level 2 - Step 3

- Mitigation scenarios
  - reduce mean
    - → move cost to more certain categories
    - → remove base cost estimate adjustments
  - reduce variance
    - → move cost to more certain categories
    - → reduce or eliminate correlation

Level 2 - Step 3

- Mitigation milestones
  - define measurable incremental milestones
  - define measurable intermediate steps
  - define milestone effectiveness

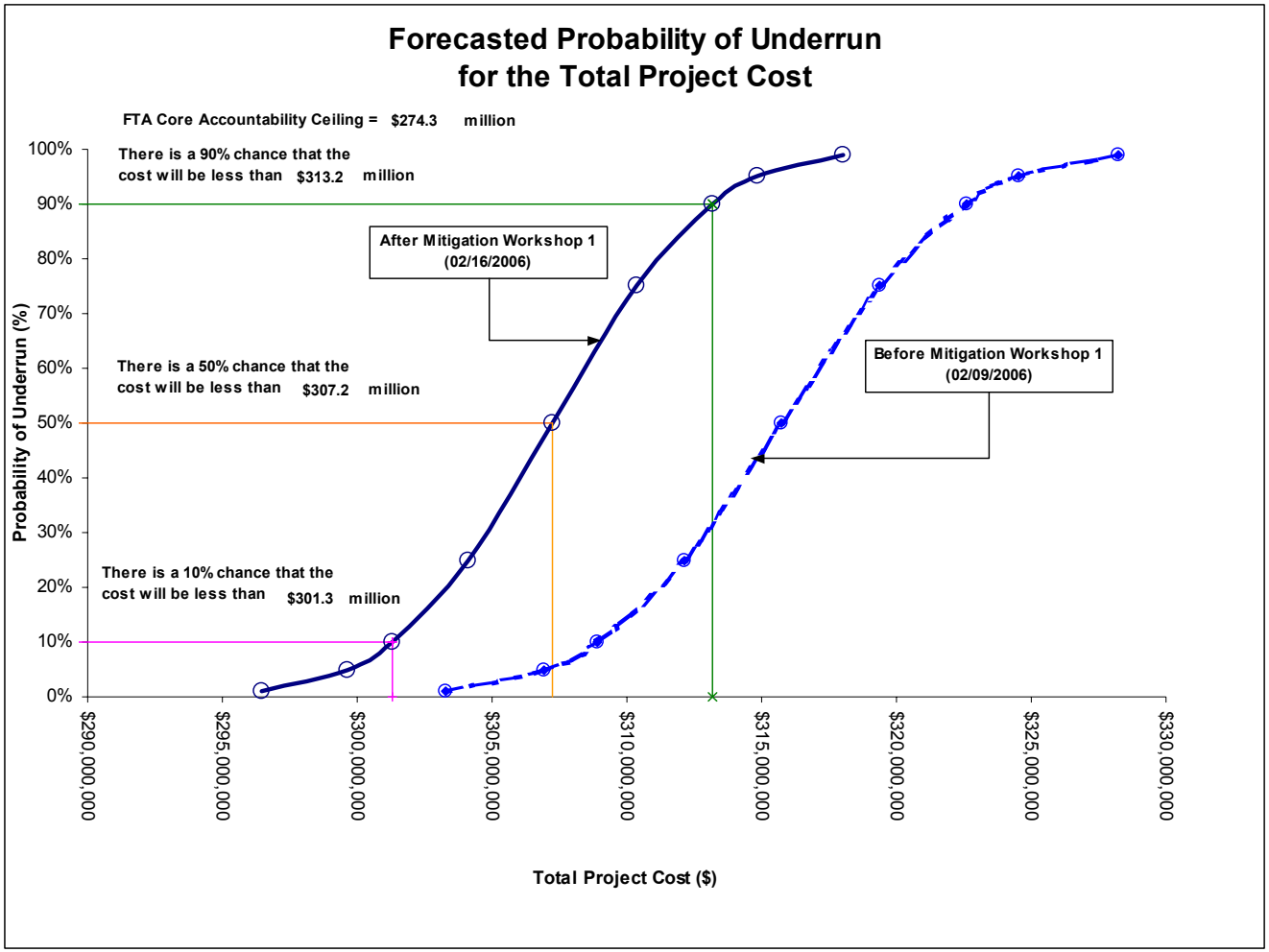
Risk Analysis - Level 3

1 _____

2 _____

3 **What are the project risks?**

Level 3 - Step 1



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Mitigation

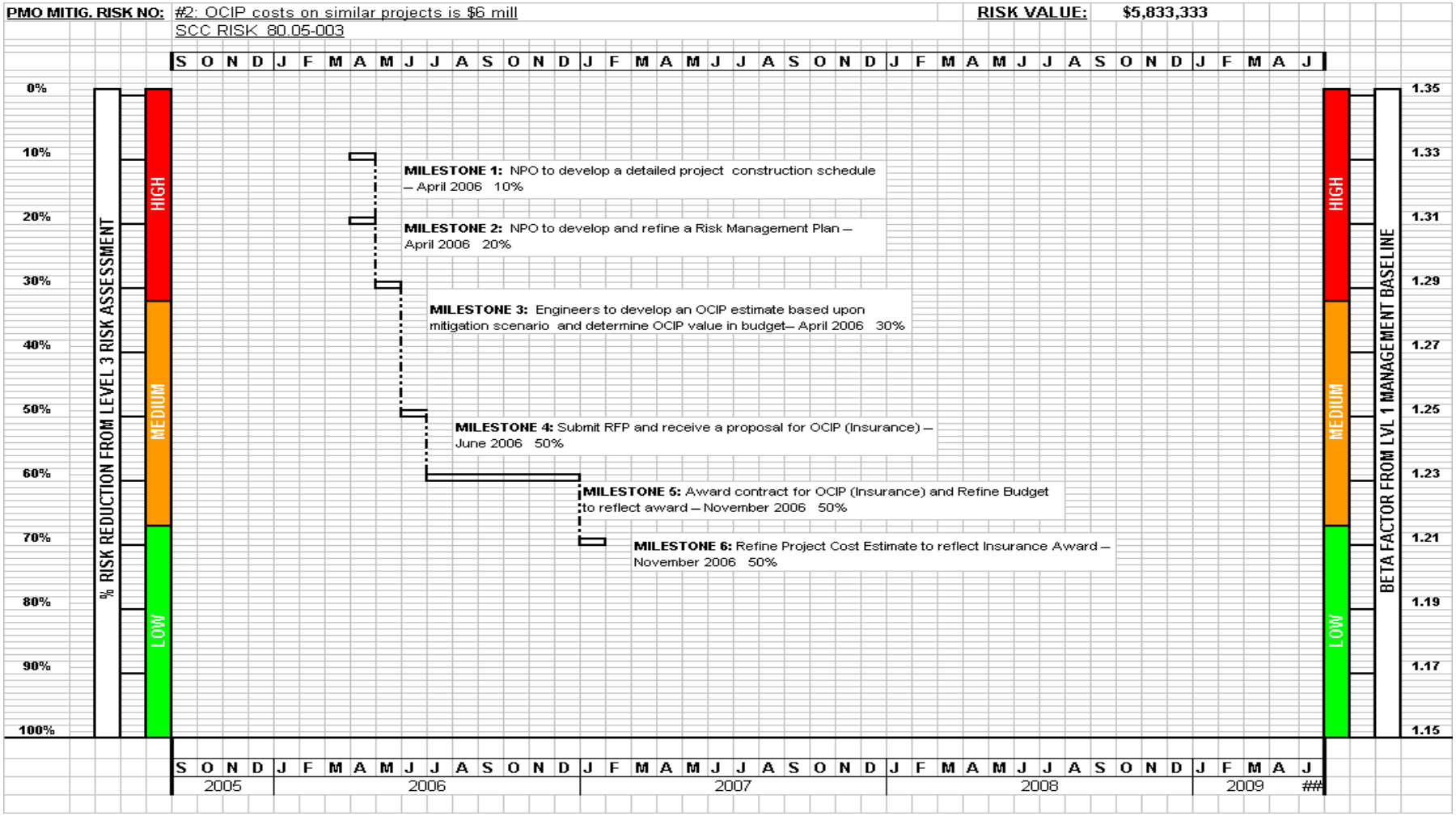
- How Do you Mitigate with Top Down and Bottom Up ??

Correlating Level 1 to Level 3 Mitigations

- A Level 3 Mitigation Plan develops mitigations for individual risks
  - Therefore, mitigations must address risks with the achievement of "time-phased" Mitigation milestones

- A Level 1 Mitigation develops mitigations at the SCC sub-element level
  - Therefore mitigations must occur to the:
    - → Beta Factors
    - → 10% Base Cost
    - → Adjustment to Base Cost
    - → Adjustment to covariance

Mitigation Scenarios – Level 3/Level 1



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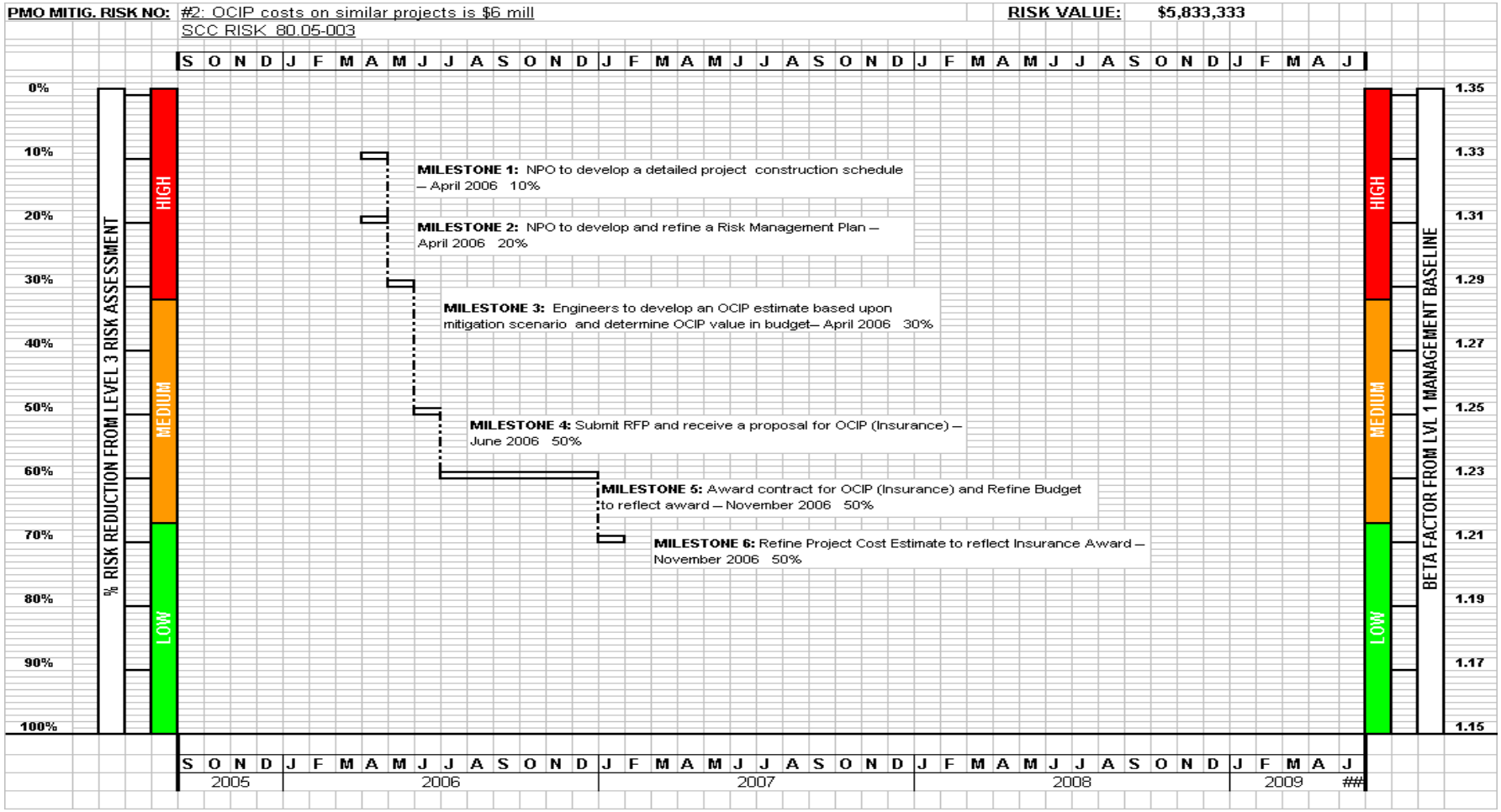
Mitigation "Specs"

- Milestone 3: NPO should prepare its case for negotiation with BNSF for reducing the costs of the easement based upon the results of the independent assessment/ appraisal performed in accordance with Milestone 2 above. In addition, NPO should develop a range in which the negotiated cost of the easement would be considered acceptable; say within 10% to 15% above the value of the independent assessment performed in the previous milestone. If the negotiation with BNSF is within the specified range, then NPO should execute an agreement and the mitigation phase for this risk element would be complete. If the costs are not within the specified range, then NPO should proceed to the next milestone

- Milestone Completion Date: August 1, 2006.
- Resultant Level-1Beta Factor: 1.79
- Resultant Level-3 Risk Reduction: 30%

Time phased Mitigation - Beta Reductions



FTA U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL TRANSIT ADMINISTRATION

JACOBS

Level 1 Mitigations

- Beta Reductions
- Base Cost Estimate – 10th percentile
- Adjustments to the 10th percentile
- Change in variance

Four Potential Mitigation elements

LEVEL ONE MILESTONE ADJUSTMENT TO MANAGEMENT BASELINE FACTORS											
	MS-0	MS-1	MS-2	MS-3	MS-4	MS-5	MS-6	MS-7	MS-8	MS-9	MS-10
BETA											
10%											
ADJST											
CVRC											

FTA U.S. DEPARTMENT OF TRANSPORTATION FEDERAL TRANSIT ADMINISTRATION

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Level 1 Mitigations

	Get All Sigmas	Budget	Contingency	Adjustments	10%	Beta Factor	90%
	SCC10-Guideways & Track						
10.01	Guideway: At-grade exclusive right-of-way	$ 1.00		$ -	$ 1.00	1.01	$ 1.01
10.02	Guideway: At-grade semi-exclusive (allows cross-traffic)	$ 1.00		$ -	$ 1.00	1.01	$ 1.01
10.03	Guideway: At-grade in mixed traffic	$ 1.00		$ -	$ 1.00	1.01	$ 1.01
10.04	Guideway: Aerial structure	$ 8,947.66	$ 585.00	$ -	$ 8,362.66	1.81	$ 15,129.69
10.05	Guideway: Built-up fill	$ 6,309.75	$ 413.00	$ -	$ 5,896.75	2.00	$ 11,793.50
10.06	Guideway: Underground cut & cover	$ 1.00		$ -	$ 1.00	1.01	$ 1.01
10.07	Guideway: Underground tunnel	$ 1.00		$ -	$ 1.00	1.01	$ 1.01
10.08	Guideway: Retained cut or fill	$ 1.00		$ -	$ 1.00	1.01	$ 1.01
10.09	Track: Direct fixation	$ 1.00		$ -	$ 1.00	1.01	$ 1.01
10.10	Track: Embedded	$ 1,110.39	$ 73.00	$ -	$ 1,037.39	1.75	$ 1,815.43
10.11	Track: Ballasted	$ 11,644.86	$ 762.00	$ 1,350.00	$ 12,232.86	2.00	$ 24,465.72
10.12	Track: Special (switches, turnouts)	$ 11,316.90	$ 740.00	$ 1,350.00	$ 11,926.90	2.00	$ 23,853.80
10.13	Track: Vibration and noise dampening	$ 1.00		$ -	$ 1.00	1.01	$ 1.01
	Contingency	$ 2,573.00					
	Total Get SCC10 Sigmas	$ 41,910.56			$ 39,464.56		$ 77,066.23

FTA U.S. DEPARTMENT OF TRANSPORTATION FEDERAL TRANSIT ADMINISTRATION

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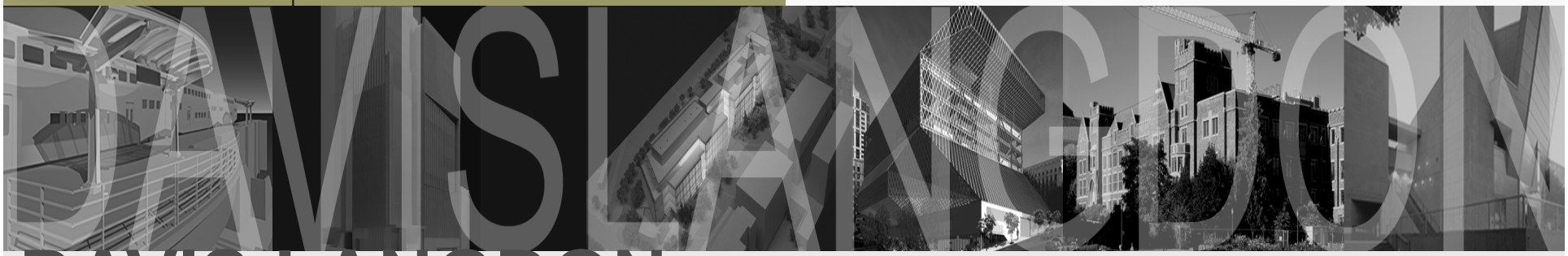
Correlation (Covariance) Mitigations

SCC Item External Correlation	10 GUIDEWAY & TRACK ELEMENTS (route miles)	20 STATIONS, STOPS, TERMINALS, INTERMODAL (number)	30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	40 SITEWORK & SPECIAL CONDITIONS	50 SYSTEMS
10 GUIDEWAY & TRACK ELEMENTS (route miles)	1.00	0.85	0.85	0.85	0.85
20 STATIONS, STOPS, TERMINALS, INTERMODAL (number)	0.85	1.00	0.85	0.85	0.85
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	0.85	0.85	1.00	0.85	0.85
40 SITEWORK & SPECIAL CONDITIONS	0.85	0.85	0.85	1.00	0.85
50 SYSTEMS	0.85	0.85	0.85	0.85	1.00

SCC Sub-Item Internal Correlation	Internal Correlation			
	design documents	design report	specifications	Undefined Scope
design documents	1.00	0.9	0.75	0.65
design report	0.9	1.00	0.9	0.75
specifications	0.75	0.9	1.00	0.9
Undefined Scope	0.65	0.75	0.9	1.00

THE Burns GROUP
ENGINEERING AND CONSTRUCTION

CENTRAL PHOENIX / EAST VALLEY LRT PROJECT



DAVIS LANGDON

Construction Cost Planning and Management

Risk Assessment Process
FTA Guidance Note 33 and 40

A MEMBER OF DAVIS LANGDON & SEAH INTERNATIONAL

San Francisco
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New York
Boston
Philadelphia

FTA U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL TRANSIT ADMINISTRATION

The Issues

- Trend established over many years that Transportation projects in particular suffer from optimism bias in cost forecasting resulting in huge over spends against original budgets (World wide problem)
- FTA experience in 'Risk Assessments' have for the most part **not been** robust in their projected range of cost forecast
- Risk mitigation has been poorly identified and implemented by Grantees
- Characterization by PMO program has been at too high a level of detail in its analysis to adequately validate a Grantees estimate to challenge optimism bias and uncover missed scope, errors and omissions

FTA HQ Objectives

- Provide a more in depth third party validation of scope, estimate and schedule
- Reduce optimism bias
- Provide more realistic and robust projected completion costs
- Clearly identify potential big ticket risks
- Provide more focused mitigation
- Provide FTA with confidence bids and construction will fall within financial projections

FTA Region Objectives

- Account for excessive cost escalation of real estate, materials and current labor market
- Was cost / bid escalation due to market forces ?
- Is there enough money to complete the project ?
- Can we mitigate any projected overspend ?

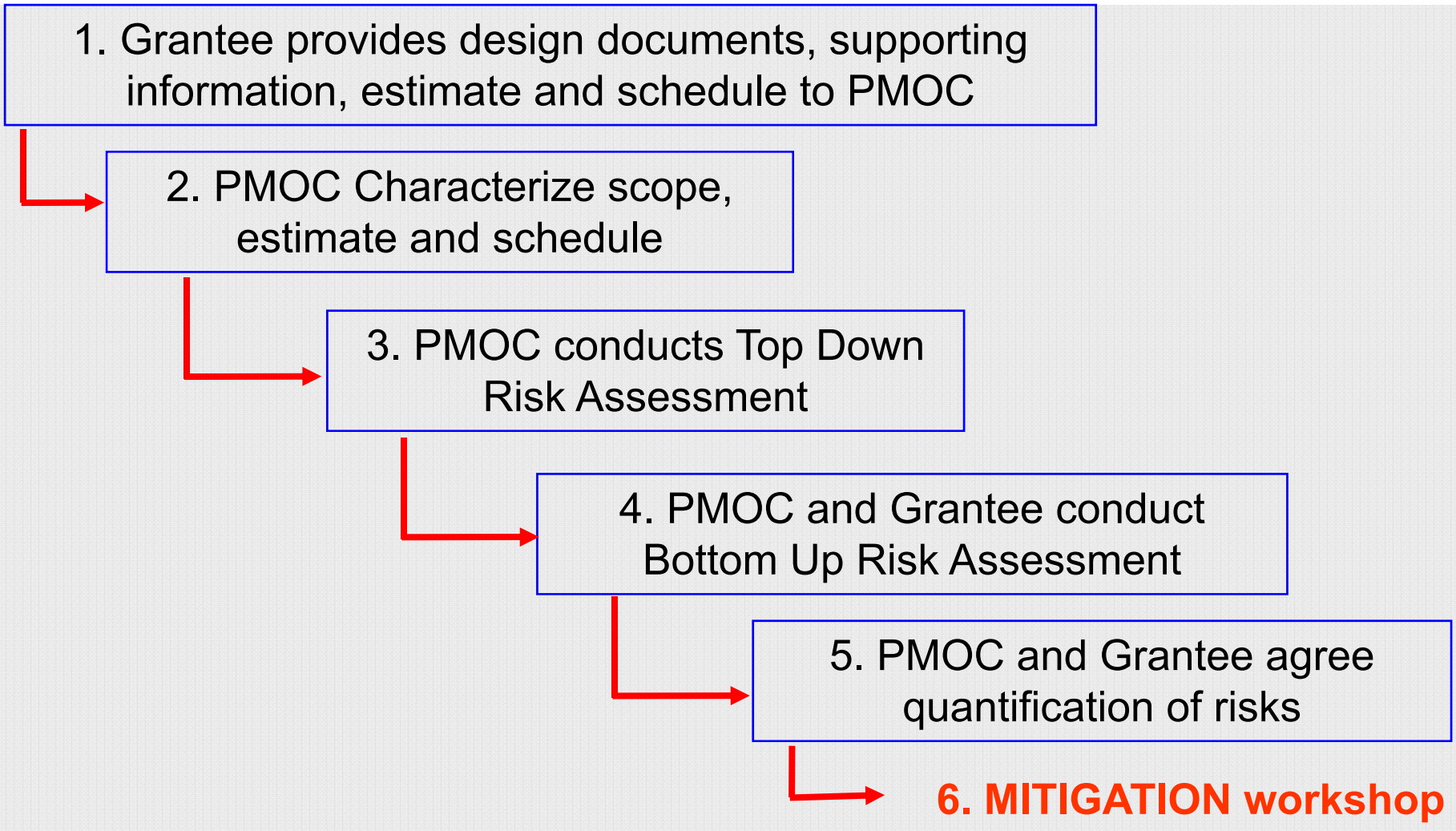
Examining Contingency

Typical Contingency allowances range from 5% to 30% of a projects estimate:

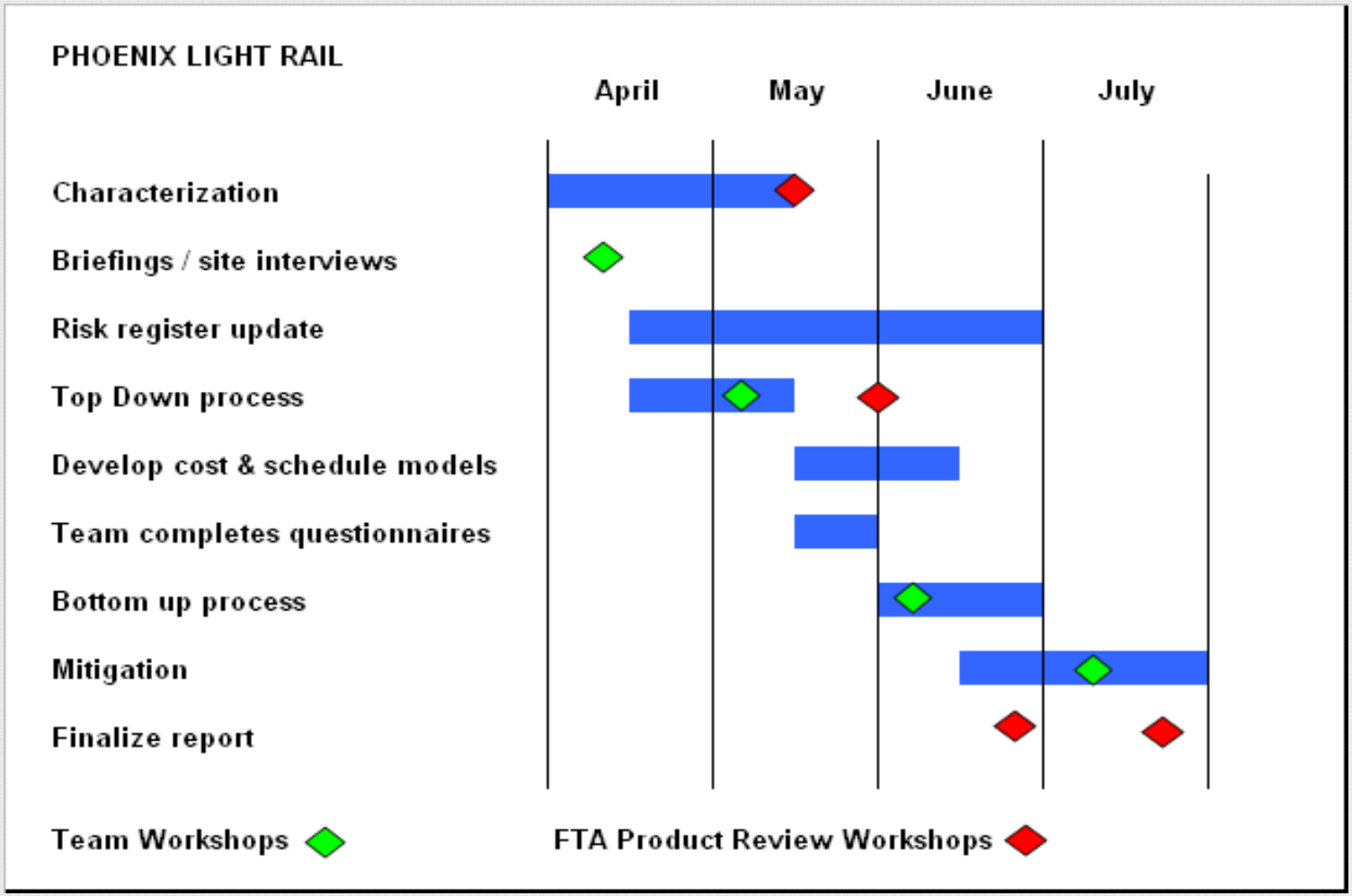
That's $ 25M to $150M on a $500M project

1. Worth talking about ?
2. Worth asking what it's for ?
3. Worth managing ?

The Risk Assessment Process



Risk Assessment Schedule



(1) New Process – Guidance Note 33

Guidance Note 33A – Characterization of Grantee Project Cost Estimate and Escalation

The PMOC requires considerable and timely information and assistance from the Grantee in order to satisfactorily complete the characterization in accordance with the FTA guidelines

(1) New Process – Guidance Note 33

Guidance Note 33A – Characterization of Grantee Project Cost Estimate and Escalation

The PMOC is tasked with checking that the estimate is:

(1) mechanically correct and complete,
(2) free of any material inaccuracies or incomplete data,
(3) consistent with relevant, identifiable industry or engineering practices,
(4) uniformly applied by the grantee's cost estimators and consistent in its method of calculation and
(5) consistent with the project scope adopted in the Record of Decision.

(1) New Process – Guidance Note 33

The PMOC is initially tasked to assess and evaluate the cost estimate by characterizing the nature of data as:

- Lump sums
- Square foot costs
- Quantity basis

And “How it was derived”

(1) New Process – Guidance Note 33

The PMOC is tasked to conduct a comprehensive review of Grantee cost data and describe the degree to which definition of project scope is captured in estimate

And then:

The PMOC is tasked to discuss the degree of traceability of scope into the projects estimate

- *We take this to refer to the degree in which the Grantee detailed estimate cross references to the design documents and how visible the estimate is in picking up change and how visible a trend program is in the cost management and forecasting of the project design development process*

(1) New Process – Guidance Note 33

The PMOC is then tasked to take the gathered data and 'adjust' the Grantees estimate to reflect inconsistencies, errors and omissions found during the characterization

This process therefore results in an 'adjusted estimate' the PMOC then has to discuss and review with the Grantee

Guidance Note 33 draws particular reference to the review and assessment of General Conditions requiring a separate analysis of the basis of the GC's

The PMOC is further tasked to conduct a comprehensive evaluation of the Grantee data that could give rise for claims including restrictive covenants and / or conditions and constraints in design and bid documents

(1) New Process – Guidance Note 33

The PMOC is then tasked to do an **independent bottom up** estimate for the **General Conditions only** * of the:

- THREE largest construction contracts and
- ONE of the Systems contracts

And finally:

- Review and examine the calculation of escalation

Where a project is in construction PG 33 goes on to require a detailed characterization of the grantees forecast costs to complete

*** We understand that the requirement for the independent bottom up estimates on GC's have been 'parked' at this time**

(1) New Process – Guidance Note 33

In addition – as Phoenix is in Construction the PMOC is tasked to check that the forecast to complete is**:**

(1) mechanically correct and complete,
(2) free of any material inaccuracies or incomplete data,
(3) consistent with relevant, identifiable industry or engineering practices,
(4) uniformly applied by the grantee's cost estimators and consistent in its method of calculation and
(5) fully integrated with and makes adequate use of grantee estimate to complete/forecast data and
(6) adequately and completely reflects grantee construction and procurement change order forecasts and data.

(1) New Process – Guidance Note 33

Pivot table : Step 1 Analysis of progress to date

PMOC ANALYSIS - GRANTEE DATA								
SCC Ref #	SCC	VALLEY METRO	ACWP	BCWP	BCWS		STATUS ANALYSIS	
		Forcast Costs to Complete	Certified (Paid) to date	Earned (PMOC analysis)	Forecast (VM Cash Flow)	To Go	Cost	Time
:		US $ M	US $ M	US $ M	US $ M	US $ M		
CONTRACT: LINE SEGMENT 1		A	B	C	D	A-B		
10 GUIDEWAY & TRACK ELEMENTS (route miles)								
10.01	Guideway: At-grade exclusive right-of-way	100.00	40.00	45.00	46.00	60.00		Behind Schedule
10.02	Guideway: At-grade semi-exclusive (allows cross-traffic)	250.00	60.00	30.00	46.00	190.00	Over Paid	Behind Schedule
10.03	Guideway: At-grade in mixed traffic							
10.04	Guideway: Aerial structure	5.00	0.50	0.30	0.20	4.50	Over Paid	
10.05	Guideway: Built-up fill							
10.06	Guideway: Underground cut & cover							
10.07	Guideway: Underground tunnel							
10.08	Guideway: Retained cut or fill							
10.09	Track: Direct fixation							
10.10	Track: Embedded							
10.11	Track: Ballasted							
10.12	Track: Special (switches, turnouts)							
10.13	Track: Vibration and noise dampening							
20 STATIONS, STOPS, TERMINALS, INTERMODAL (number)								
20.01	At-grade station, stop, shelter, mall, terminal, platform	30.00	25.00	26.00	29.00	5.00		Behind Schedule
20.02	Aerial station, stop, shelter, mall, terminal, platform							
20.03	Underground station, stop, shelter, mall, terminal, platform							
20.04	Other stations, landings, terminals: Intermodal, ferry, trolley, etc.							
20.05	Joint development							
20.06	Automobile parking multi-story structure							
20.07	Elevators, escalators							

SCC by Contract Package

All figures are 'plug' numbers

(1) New Process – Guidance Note 33

Pivot table : Step 2 Analysis of Contract Packages

PMOC ANALYSIS - GRANTEE DATA																	
SCC Ref #	SCC	Unit Prices				Lump Sums				CER'S					Change Orders			Totals
		Issues	Design / Firm	Issues	Provisional	Issues	Fixed	Issues	Provisonal	Issues	On Fixed Costs	Issues	On Variable Costs		Agreed	Provisional (Trends)	Issues	
:			US $ M		US $ M		US $ M		US $ M		US $ M		US $ M					US $ M
CONTRACT: LINE SEGMENT 1																		
10 GUIDEWAY & TRACK ELEMENTS (route miles)																		
10.01	Guideway: At-grade exclusive right-of-way	0	45.00	3	30.00	0	12.00	8	5.00	1	2.00	4	1.00	1	4.00	1.00	17	100.00
10.02	Guideway: At-grade semi-exclusive (allows cross-traffic)	0	200.00	0	-	12	12.00	0	10.00	4	6.00	3	3.00	0	7.00	12.00	19	250.00
10.03	Guideway: At-grade in mixed traffic																	
10.04	Guideway: Aerial structure	0	-	0	-	4	5.00	0	-	0	-	0	-	0	-	-	4	5.00
10.05	Guideway: Built-up fill																	
10.06	Guideway: Underground cut & cover																	
10.07	Guideway: Underground tunnel																	
10.08	Guideway: Retained cut or fill																	
10.09	Track: Direct fixation																	
10.10	Track: Embedded																	
10.11	Track: Ballasted																	
10.12	Track: Special (switches, turnouts)																	
10.13	Track: Vibration and noise dampening																	
20 STATIONS, STOPS, TERMINALS, INTERMODAL (number)																		
20.01	At-grade station, stop, shelter, mall, terminal, platform	10	20.00	6	5.00	0	-	0	-	0	-	0	-	1	5.00	-	17	30.00
20.02	Aerial station, stop, shelter, mall, terminal, platform																	
20.03	Underground station, stop, shelter, mall, terminal, platform																	

(1) New Process – Guidance Note 33

Pivot table : Step 3 Analysis of data

Less than	5 % Provisional	GREEN
Between	5 % and 25 % Provisional	YELLOW
Greater than	25 % Provisional	RED

(1) New Process – Guidance Note 33

Pivot table : Step 3 Analysis of data

PMOC ANALYSIS - GRANTEE DATA		PMOC ANALYSIS										
SCC Ref #	SCC	ACWP	BCWP	BCWS	UNIT PRICES		LUMP SUMS		CER'S		Change Orders	
		Certified (Paid) to date	Earned (PMOC analysis)	Forecast (VM Cash Flow)	Design / Firm	Provisional	Fixed	Provisonal	On Fixed Costs	On Variable Costs	Agreed	Provisional (Trends)
:		% PAID	% COMPLETE	% Planned	% of FC	% of FC	% of FC	% of FC	% of FC	% of FC	% of FC	% of FC
CONTRACT: LINE SEGMENT 1												
10 GUIDEWAY & TRACK ELEMENTS (route miles)												
10.01	Guideway: At-grade exclusive right-of-way	40%	45%	46%	45%	30%	12%	5%	2%	1%	4%	1%
10.02	Guideway: At-grade semi-exclusive (allows cross-traffic)	24%	12%	18%	80%	0%	5%	4%	2%	1%	3%	5%
10.03	Guideway: At-grade in mixed traffic											
10.04	Guideway: Aerial structure	10%	6%	4%	0%	0%	100%	0%	0%	0%	0%	0%
10.05	Guideway: Built-up fill											
10.06	Guideway: Underground cut & cover											
10.07	Guideway: Underground tunnel											
10.08	Guideway: Retained cut or fill											
10.09	Track: Direct fixation											
10.10	Track: Embedded											
10.11	Track: Ballasted											
10.12	Track: Special (switches, turnouts)											
10.13	Track: Vibration and noise dampening											
20 STATIONS, STOPS, TERMINALS, INTERMODAL (number)												
20.01	At-grade station, stop, shelter, mall, terminal, platform	83%	87%	97%	67%	17%	0%	0%	0%	0%	17%	0%
20.02	Aerial station, stop, shelter, mall, terminal, platform											
20.03	Underground station, stop, shelter, mall, terminal, platform											
20.04	Other stations, landings, terminals: Intermodal, ferry, trolley, etc.											
20.05	Joint development											
20.06	Automobile parking multi-story structure											

Top Down Model – Guidance Note 40

	LEAD	SUPPORT
PROGRAM - LEVEL 1	FTA	PMOC
TOP DOWN - LEVEL 2	PMOC	FTA
BOTTOM UP – LEVEL 3	PMOC	GRANTEE

In Bottom up Grantee provides cost and schedule input data for analysis – Level 1 challenges Level 2, Level 2 challenges Level 3, Characterization supports interrogation and provides basis for mitigation

Top Down Model – STEP 1

PROGRAM LEVEL 1 – FTA internal 'TARGET' range and monitor

(1) Determine 'raw' BCE's to arrive at 10 percentile:

- Allocate estimate to SCC codes
- Deduct spent to date values
- Adjust to omit allocated contingency

(2) Calculate 90 percentile:

- Apply factor to 10 percentile to arrive at 90 percentile – PMOC discretion BUT minimum 100% (except where in construction)
- Calculate 'mean' and 'standard deviation' for each SCC
- Add back 'spent values' and determine percentile target values (typically 10%, 20%, 30%, 40%, 50%, 60%, 70% and 75%)

Top Down Model – STEP 1

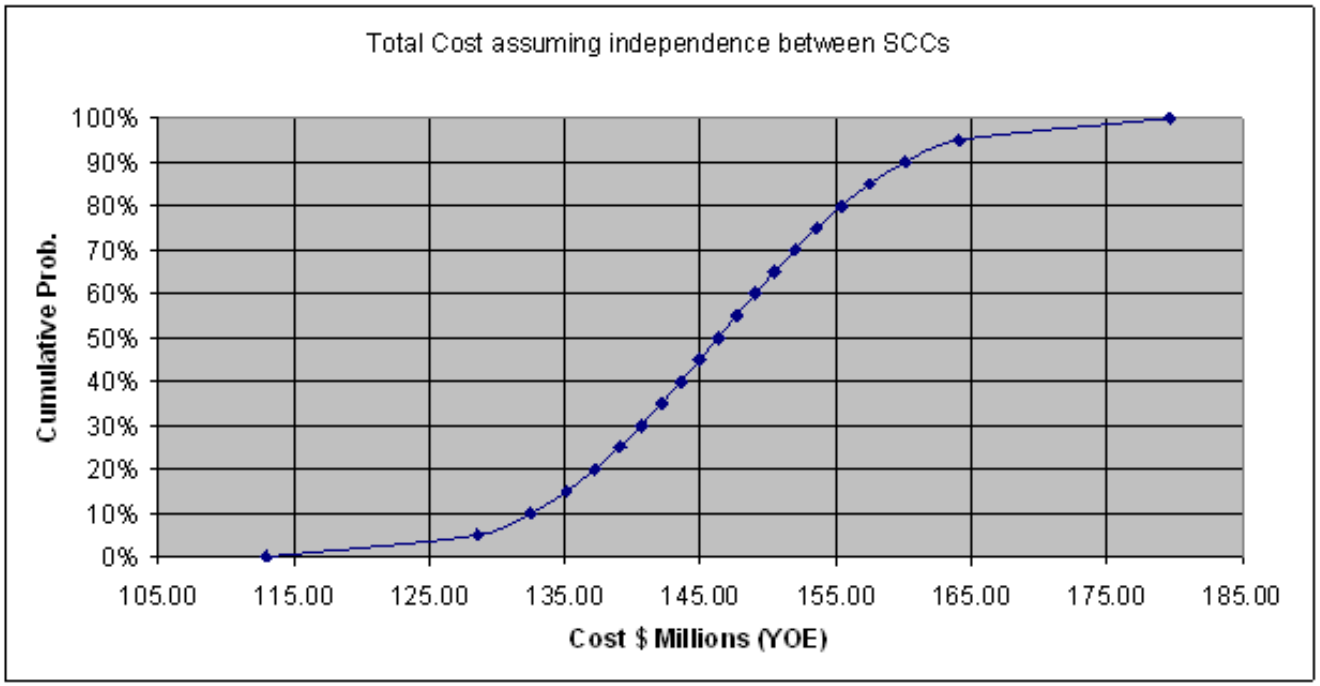
PROGRAM LEVEL 1 – FTA internal 'TARGET' range and monitor

SCC	TRI MET Budget	Deduct Spent	Adjust to 10% (+/-)	10%	Factor	90%
10.01 - Guideway: At-grade exclusive right-of-way	$ 4,089,463	$ -	$ -	$ 4,089,463	100%	$ 8,178,925.65
10.02 - Guideway: At-grade semi-exclusive (allows cross-traffic)	$ 72,196	$ -	$ -	$ 72,196	100%	$ 144,392.00
10.04 - Guideway: Aerial structure	$ 6,973,204	$ -	$ -	$ 6,973,204	100%	$ 13,946,408.00
10.10 - Track embedded	$ 413,350	$ -	$ -	$ 413,350	100%	$ 826,700.00
10.11 - Track Ballast	$ 9,027,358	$ -	$ -	$ 9,027,358	100%	$ 18,054,715.65
10.12 - Track special (switches and turnouts)	$ 3,452,035	$ -	$ -	$ 3,452,035	100%	$ 6,904,070.00
20.01 - At-grade station, stop, shelter, mall, terminal, platform	$ 3,482,952	$ -	$ -	$ 3,482,952	100%	$ 6,965,903.65
30.02 - Light maintenance facility	$ 3,586,260	$ -	$ -	$ 3,586,260	100%	$ 7,172,519.53
40.01 - Demolition, clearing and earthworks	$ 3,562,244	$ -	$ -	$ 3,562,244	100%	$ 7,124,488.00
40.02 - Site Utilities, Utility Relocation	$ 1,258,039	$ -	$ -	$ 1,258,039	100%	$ 2,516,078.00
40.03 - Haz Mat'l, Contaminated Soil Removal	$ 179,529	$ -	$ -	$ 179,529	100%	$ 359,058.82
40.04 - Environmental Mitigation	$ 250,500	$ -	$ -	$ 250,500	100%	$ 501,000.00
40.05 - Site structures including retaining walls, sound walls	$ 581,112	$ -	$ -	$ 581,112	100%	$ 1,162,224.00
40.06 - Pedestrian / bike access and accommodation, landscaping	$ 1,319,700	$ -	$ -	$ 1,319,700	100%	$ 2,639,400.00
40.07 - Automobile, bus, van accessways including roads, parking lots	$ 2,347,344	$ -	$ -	$ 2,347,344	100%	$ 4,694,688.00
40.08 - Temp Facilities & Other Indirects - Constr						

Top Down Model – STEP 1

PROGRAM LEVEL 1 – FTA internal 'TARGET' range and monitor

Confidence level	$ US (M)
0%	112.95
5%	128.56
10%	132.48
15%	135.13
20%	137.23
25%	139.03
30%	140.65
35%	142.15
40%	143.58
45%	144.96
50%	146.31
55%	147.67
60%	149.05
65%	150.47
70%	151.98
75%	153.60
80%	155.40
85%	157.50
90%	160.15
95%	164.07
100%	179.68



Top Down Model – STEP 1

PROGRAM LEVEL 1 – FTA internal 'TARGET' range and monitor

SSC Ref	SSC Title	Worst Case' Lower 10%	+20%	+30%	+40%	+50%	+60%	+70%	+75%
10.01	Guideway: At-grade exclusive right-of-way	4.09	4.61	5.13	5.58	6.00	6.42	6.87	7.11
10.02	Guideway: At-grade semi-exclusive (allows cross-traffic)	0.07	0.08	0.09	0.10	0.11	0.11	0.12	0.13
10.04	Guideway: Aerial structure	6.97	7.86	8.75	9.52	10.23	10.94	11.71	12.13
10.10	Track embedded	0.41	0.47	0.52	0.56	0.61	0.65	0.69	0.72
10.11	Track Ballast	9.03	10.17	11.33	12.32	13.24	14.17	15.15	15.70
10.12	Track special (switches and turnouts)	3.45	3.89	4.33	4.71	5.06	5.42	5.80	6.00
20.01	At-grade station, stop, shelter, mall, terminal, platform	3.48	3.92	4.37	4.75	5.11	5.47	5.85	6.06
30.02	Light maintenance facility	3.59	4.04	4.50	4.89	5.26	5.63	6.02	6.24
40.01	Demolition, clearing and earthworks	3.56	4.01	4.47	4.86	5.23	5.59	5.98	6.20
40.02	Site Utilities, Utility Relocation	1.26	1.42	1.58	1.72	1.85	1.97	2.11	2.19
40.03	Haz Mat'l, Contaminated Soil Removal	0.18	0.20	0.23	0.24	0.26	0.28	0.30	0.31
40.04	Environmental Mitigation	0.25	0.28	0.31	0.34	0.37	0.39	0.42	0.44
40.05	Site structures including retaining walls, sound walls	0.58	0.65	0.73	0.79	0.85	0.91	0.98	1.01
40.06	Pedestrian / bike access and accommodation, landscaping	1.32	1.49	1.66	1.80	1.94	2.07	2.22	2.30
40.07	Automobile, bus, van accessways including roads, parking lot	2.35	2.65	2.95	3.20	3.44	3.68	3.94	4.08
40.08	Temp Facilities & Other Indirects - Constr	4.10	4.62	5.14	5.59	6.01	6.43	6.88	7.12

PMOC send's LEVEL 1 to HQ Mike O'Connor

Top Down Model – STEP 2

PROGRAM LEVEL 2 – establish 'TARGET' variance

Objective:

- Gut feel of variance between10-90 percentile (referred to as10-90 Beta)
- Target for comparison with calculated variance from detail sheets

Characterization must have been completed

PMOC required to submit 'Target Variances' as part of regular progress reporting to FTA HQ

Top Down Model – STEP 2

PROGRAM LEVEL 2 – Complete detail sheets for each SCC

Objective:

- Use knowledge gathered from characterization
- High level overview of issues and risks
- Independent assessment of cost exposure and robustness of each SCC
- Uses only 10% and 90% input – most likely viewed as biased towards optimism

Top Down Model – STEP 2

PROGRAM LEVEL 2 – Complete detail sheets for each SCC

Unit	Unit Description
10.01 - Guideway: At-grade exclusive right-of-way	
Items Reviewed by Burns Engineering Inc	
R1	Vol. One Track-System Drawings
R2	Tech. Specifications
R3	Green Book Costs
R4	ComRail Rev. 3P Revisions
R5	WBCR SCC Cost Characterizations
R6	Wilsonville Maintenance Facility Drawings #1 &#2
R7	Fed. Railroad Safety Requirements
R8	Preliminary Engineering Plans
R9	Preliminary Engineering Report
R10	Track System Station 2004
R11	Project Estimate/Schedule 10/28/04
R12	Project Management Plan for Design & Construction
Design Risk/Issues/Mitigations	
D1	Station Platform Design Brige plate instalation problems
D2	Vehicle fueling facility EPA aproval
D3	Vehicle washing facility EPA aproval
D4	Utilities locations, unadentified lines, unknown lines & owners
Construction Risk/Issues/Mitigations	
C1	P811 Track building machine, corridination with supplies,
C2	availablity time, brakedowns. Parts, at-grade crossings
C3	Material availablity
C4	Manpower availablity, other projects in the area that would drawn skilled labor
C5	Utilities locations, unadentified lines, unknown lines & owners
Schedule Risk/Issues/Mitigations	
S1	P811 Track building machine
S2	Material availablity
S3	Manpower availablity, other projects in the area that would drawn skilled labor
S4	Utilities locations, unadentified lines, unknown lines & owners
Escalation / Market Forces	
E1	Material availablity
E2	Manpower availablity, other projects in the area that would drawn skilled labor

Status of Drawings/Specifications/Estimate

Drawings and specifications were at 75% CD incorporating review comments
Estimate basis was August 2005 with value engineering incorporated into the 'Green Book' to produce a revised 75% CD estimate

TM Budget (YOE):	$4,089,463	TM Schedule Start Date:	
TM Const. Contingency:	$0	TM Schedule Finish Date:	
TM Total (YOE):	$4,089,463	TM Schedule Duration:	
TM Escalation Factor:	0%		
TM Escalated (YOE):	$4,089,463		

Risk Assessment

0%	Expended costs to date :	$ -	$ -
100%	Costs to go:	$4,089,463	
Revised	Baseline Estimate (10%):	$ 4,089,463	

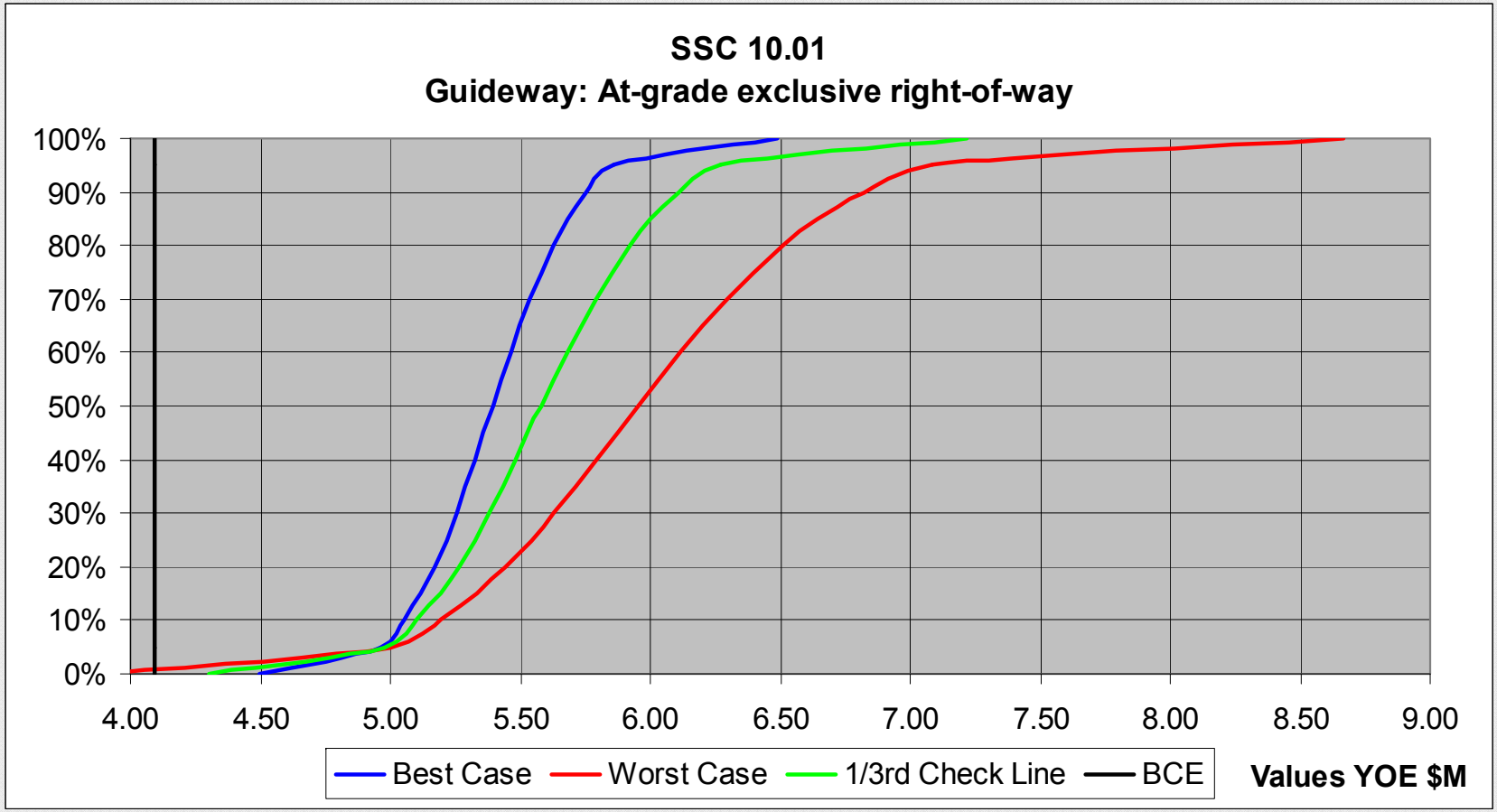
Contingency Allocation	Lower Boundary (10th)		Most Likely (50th) - FIO		Upper Boundary (90th)	
	%	$	%	$	%	$
Design	1	40,895	0	0	5	204,473
Construction	5	204,473	0	0	10	408,946
Schedule	15	613,419	0	0	30	1,226,839
Total	21	858,787	0	0	45	1,840,258
						25.53191489

Risk Assessment	Contingency Range		Escalated Range			
	%	$	%	$	%	$
Lower 10th	21	4,948,250	5	5,195,663	0	0
Upper 90%	45	5,929,721	15	6,819,179	0	0

Notes and Additional Comments

Top Down Model – STEP 2

PROGRAM LEVEL 2 – Best case, worst case and 1/3rd 'Check Line



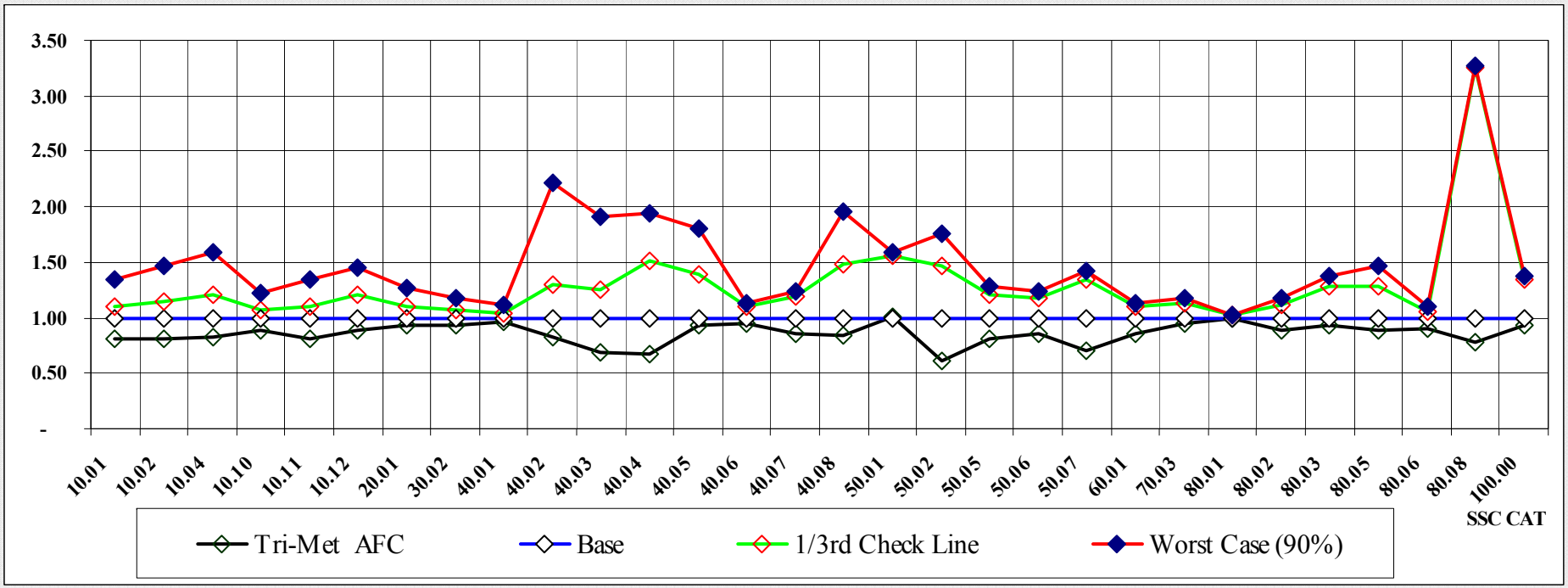
Top Down Model – STEP 2

PROGRAM LEVEL 2 – Analysis & comparison with Target Variance

SCC Ref	SSC Title	Theroretical 0%	Lower 10%	25% Lower Quartile	Most Likely 50%	75% Upper Quartile	Upper 90%	Theoretical 100%	Actual Variance (10/90)	Target Variance (10/90)
10.01	Guideway: At-grade exclusive right-of-way	3.91	5.20	5.54	5.95	6.39	6.82	8.67	31%	15%
10.02	Guideway: At-grade semi-exclusive (allows cross-traffic)	0.08	0.10	0.11	0.11	0.12	0.13	0.17	30%	15%
10.04	Guideway: Aerial structure	5.14	8.52	9.49	10.70	12.05	13.42	20.92	58%	50%
10.10	Track embedded	0.42	0.48	0.50	0.52	0.55	0.57	0.67	18%	10%
10.11	Track Ballast	8.67	11.47	12.23	13.14	14.11	15.05	20.50	31%	15%
10.12	Track special (switches and turnouts)	2.85	4.17	4.37	4.76	5.18	5.59	8.01	34%	15%
20.01	At-grade station, stop, shelter, mall, terminal, platform	3.04	3.85	3.98	4.23	4.50	4.75	6.22	24%	25%
30.02	Light maintenance facility	3.36	3.94	4.02	4.19	4.36	4.52	5.26	15%	10%
40.01	Demolition, clearing and earthworks	3.38	3.74	3.80	3.90	4.01	4.11	4.62	10%	10%
40.02	Site Utilities, Utility Relocation	0.82	1.72	1.91	2.33	2.84	3.40	6.71	98%	100%
40.03	Haz Mat'l, Contaminated Soil Removal	0.18	0.32	0.34	0.39	0.45	0.50	0.83	59%	150%
40.04	Environmental Mitigation	0.26	0.44	0.48	0.55	0.63	0.72	1.17	62%	20%
40.05	Site structures including retaining walls, sound walls	0.38	0.69	0.74	0.86	0.99	1.13	1.93	65%	75%
40.06	Pedestrian / bike access and accommodation, landscaping	1.14	1.39	1.42	1.48	1.54	1.59	1.84	14%	10%
40.07	Automobile, bus, van accessways including roads, parking lots	2.13	2.70	2.79	2.98	3.17	3.36	4.19	24%	15%
40.08	Temp Facilities & Other Indirects - Constr	3.00	5.53	6.02	7.05	8.26	9.52	16.52	72%	75%
50.01	Train Control & Signals	8.67	12.66	13.36	14.75	16.28	17.80	26.16	41%	80%
50.02	Traffic Signals / Crossing Protection	1.29	2.09	2.22	2.50	2.81	3.11	4.79	49%	95%
50.05	Communications	1.16	1.52	1.58	1.69	1.81	1.93	2.45	27%	55%
50.06	Fare Collection System & Equipment	0.42	0.57	0.59	0.63	0.67	0.71	0.94	25%	15%
50.07	Central Control	0.25	0.42	0.44	0.49	0.55	0.61	0.88	46%	50%
60.01	Purchase or Lease of Real Estate	6.04	7.34	7.50	7.80	8.11	8.40	9.98	14%	15%
70.03	Commuter Rail Vehicles	14.92	17.89	18.32	19.16	20.03	20.84	24.70	16%	10%
80.01	Preliminary Engineering	6.92	7.05	7.07	7.11	7.15	7.19	7.37	2%	5%
80.02	Final Design	0.73	0.88	0.90	0.94	0.98	1.02	1.18	16%	15%
80.03	Project Mgmt for Design & Constr	4.21	5.51	5.72	6.15	6.61	7.07	9.23	28%	65%
80.05	Insurance	1.48	2.17	2.28	2.51	2.76	3.01	4.18	39%	25%
80.06	Legal; Permits; Review Fees	1.04	1.13	1.15	1.17	1.20	1.22	1.34	8%	15%
80.08	Agency Force Account	0.15	0.42	0.48	0.63	0.82	1.05	2.67	151%	300%
100.00	Finance charges	4.36	5.97	6.21	6.68	7.19	7.69	10.71	29%	20%

Top Down Model – STEP 2

PROGRAM LEVEL 2 – Graph Boundaries



Looking for a realistic spread between 10 and 90 percentiles

1/3rd CHECK LINE established as 'Target' for Bottom up comparison

Bottom Down Model – STEP 3

PROGRAM LEVEL 3

- Review Valley Metro Risk Register
- Issue pre workshop handbook and questionnaire
- Build Cost and schedule risk models
- Validate models with Valley Metro
- Hold bottom up workshop
- Update risk register
- Develop and run risk models
- Discuss results
- Hold mitigation workshop
- Re-run models and finalize report

Risk Register

PROJECT RISK REGISTER

LA METRO EAST SIDE EXTENSION

REV : 1

DATE ISSUED : MARCH 22 2006

PROJECT RISK MATRIX	Low (1)	Med (2)	High (3)	Legend
Probability	< 10%	<> 10-50%	> 50%	LOW
Cost ($)	< $100K	<>100 - 500K	> $500k	MED
Time (Months)	< 2 WKS	<> 2-8 WKS	> 8 WKS	HIGH

BCE Unit ID	Risk ID	Description of Risk Event	Impact of Risk Event	Probability %	Potential Cost	Potential Time Impact	Risk Level
20.01	34	MTA share of 710 bridge works could increase This entire work is financed by MTA.	Cutting out middle of bridge - Caltrans could change design - value has been front loaded and is not representative - additional restrictions could be placed on working over 710	25%	3	2	63
20.01	35	Contract 0803 Provisional quantities for station delays and additional works could change	Allocation of provisional sums has been made to cost codes and discrete risks	75%	2	1	113
20.01	36	Access at Ramona HS on base case may be delayed	Potential 2-6 months late. Real Estate and Utility costs, legal other administration costs may be increased. Contractor has said he does not need access till next year therefore little RISK of delay to project / follow on activities	100%	1	1	100

Project Cost Risk Analysis

Where it all starts...

Pre Workshop Questionnaire

Project Cost Risk Analysis

Definitions

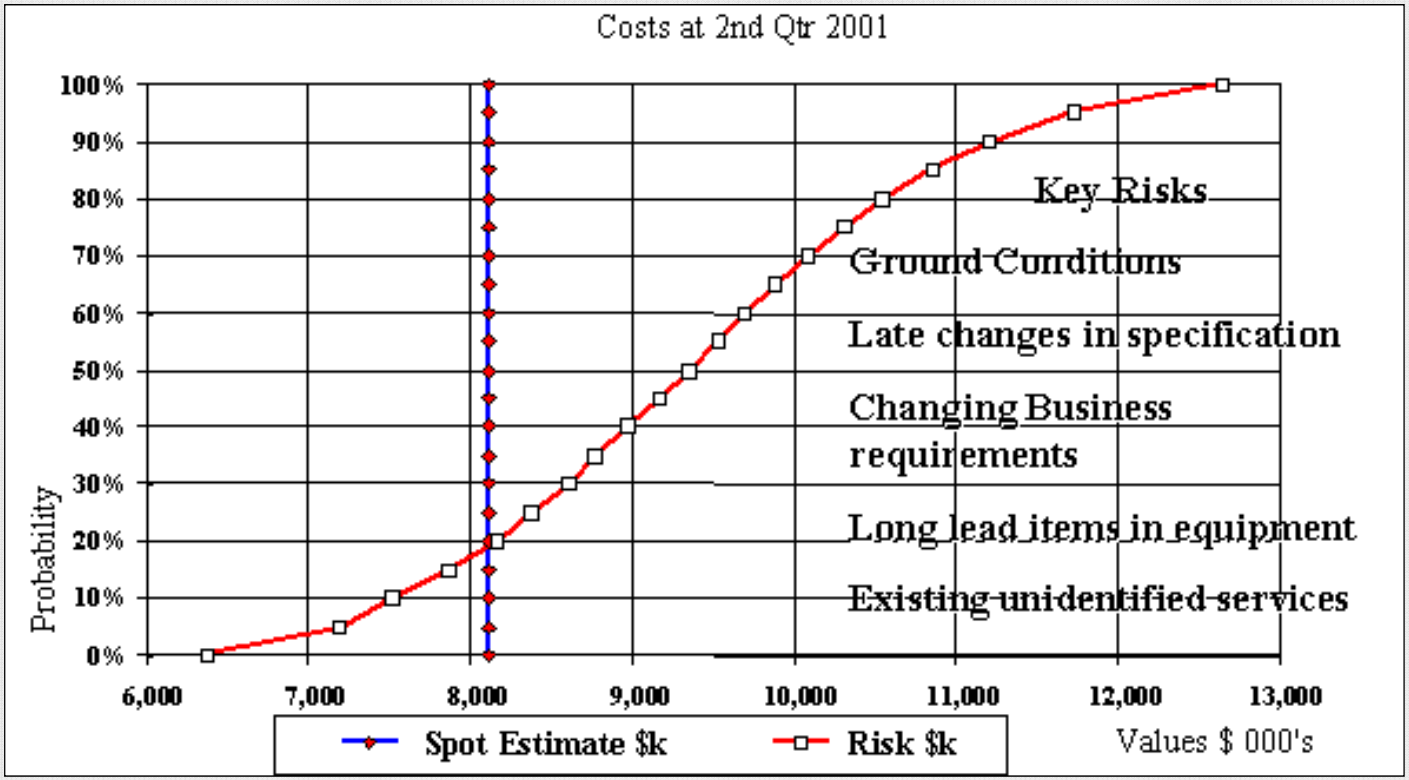
P for Probability

BCE for Baseline Cost Estimate

SCC for Standard Cost Category

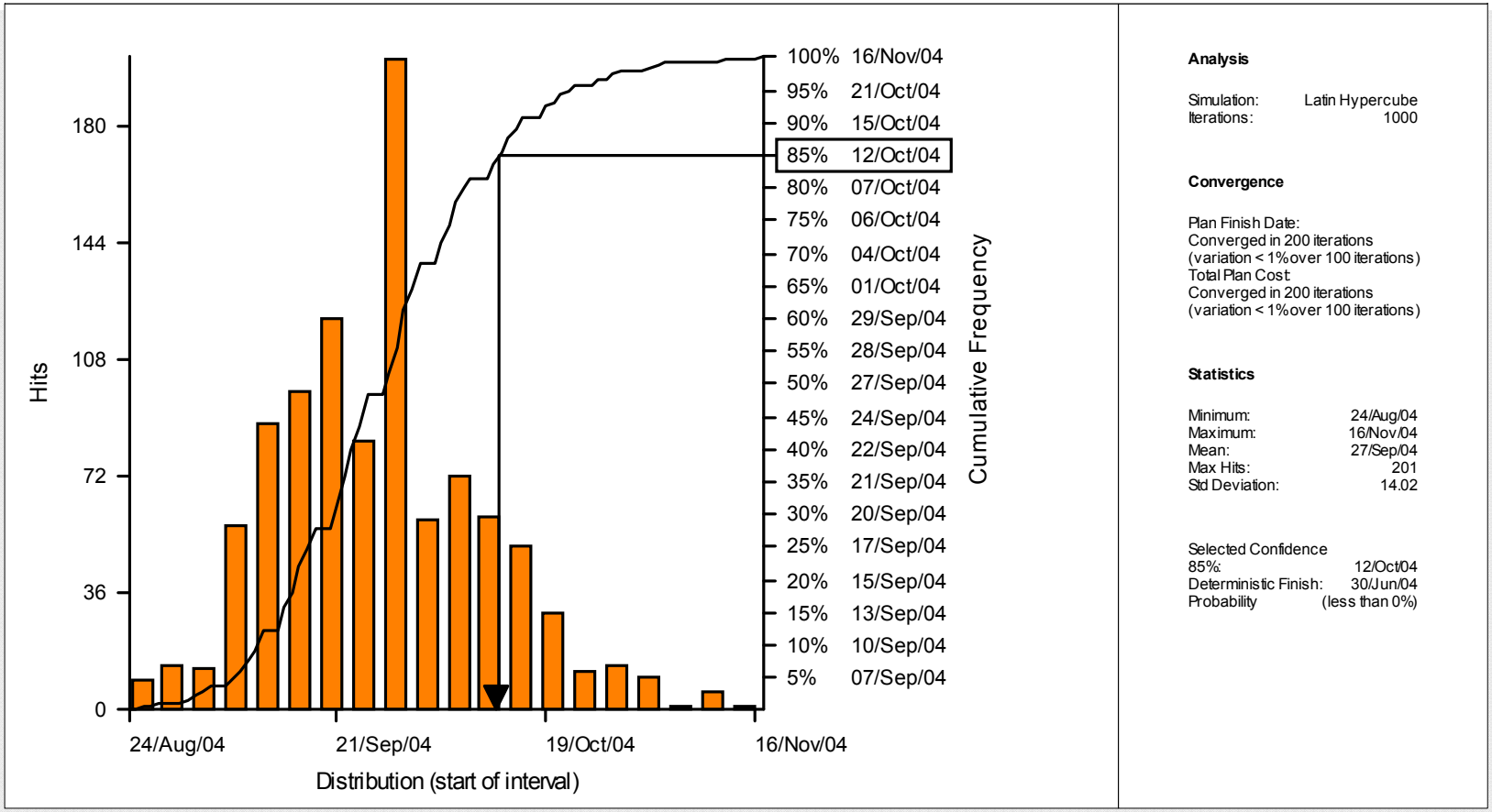
Cumulative Probability Curve

Project Cost Risk Analysis



WHERE DO YOU THINK THE ESTIMATE FOR YOUR PROJECT IS ?

Project Cost Risk Analysis



HOW CONFIDENT ARE YOU IN THE FINISH DATE OF YOUR PROJECT?

Our Objectives

- Positive help to Valley Metro project team
- Ensure risk assessment process provides ‘value’ added benefits to project
- Satisfy FTA HQ objectives
- Satisfy FTA Region objectives

Questions & Answers

Jerry DiMondo
PMO Project Manager

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FTA Risk Assessment

Updated methods

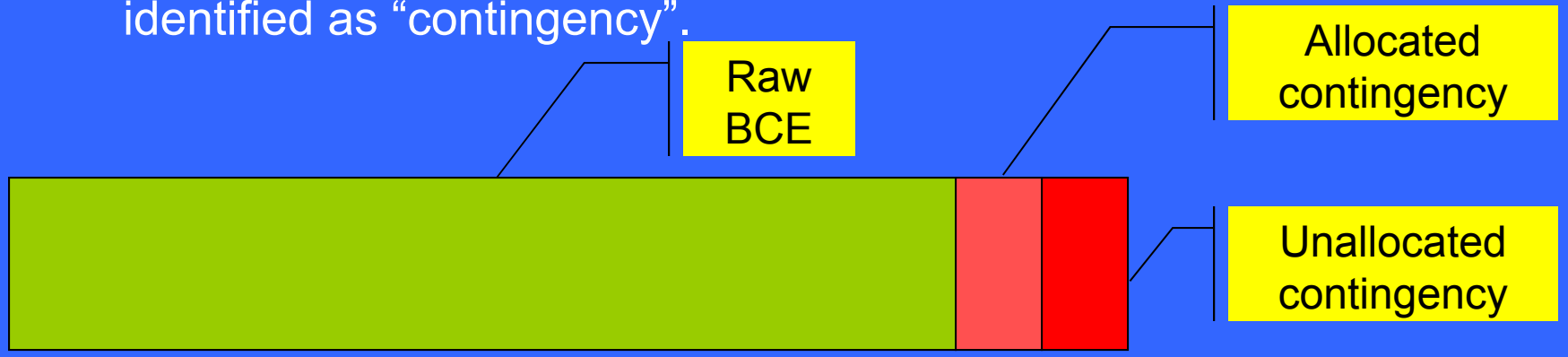
David N. Sillars, Ph.D., P.E
CEM 552.

Agenda

- Risk Assessment underlying concepts
- The PG-22 concepts
- Moving from the PG-22 to the PG-40
- The PG-40 concepts

Risk assessment underlying concepts

- Most BCEs are developed with some amount of "Risk" accounted for in the estimate, through either:
  - Allocated contingency estimates (that attached to specific line items, often "buried" within the line-item costs, or
  - Unallocated contingency estimate, often included as a line-item identified as "contingency".

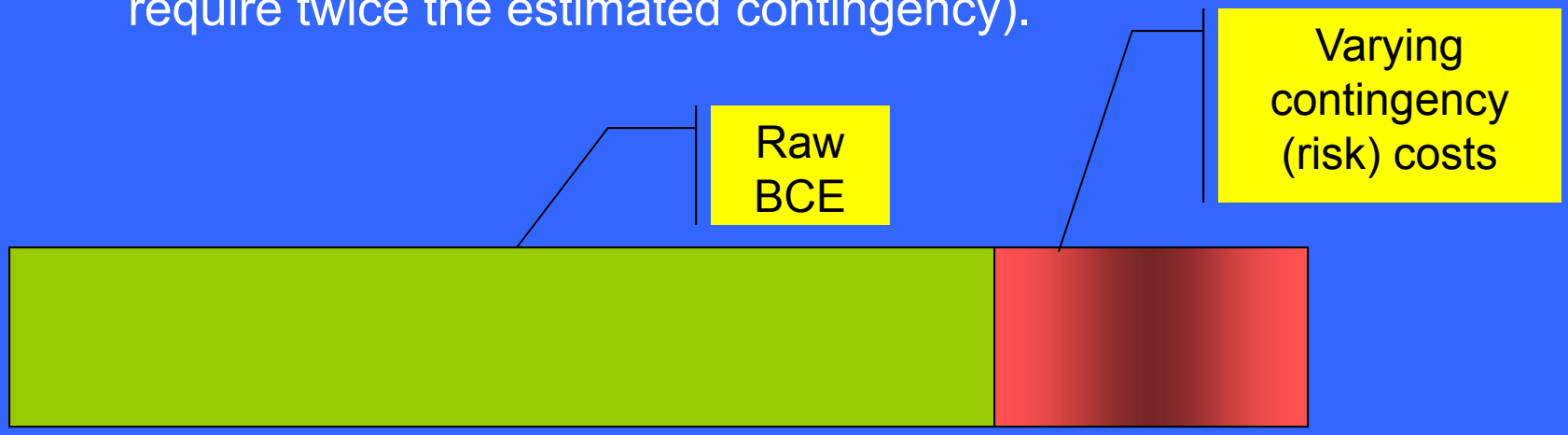


Risk assessment underlying concepts

- Contingencies included in typical BCEs:
  - are included at a specific value;
  - are frequently inserted as broad “rules of thumb” (“5%”, “7%”, “10%”, etc.);
  - do not recognize that the “Risk” costs may vary, and
  - do not highlight what happens to those costs if the risk issue is mitigated.

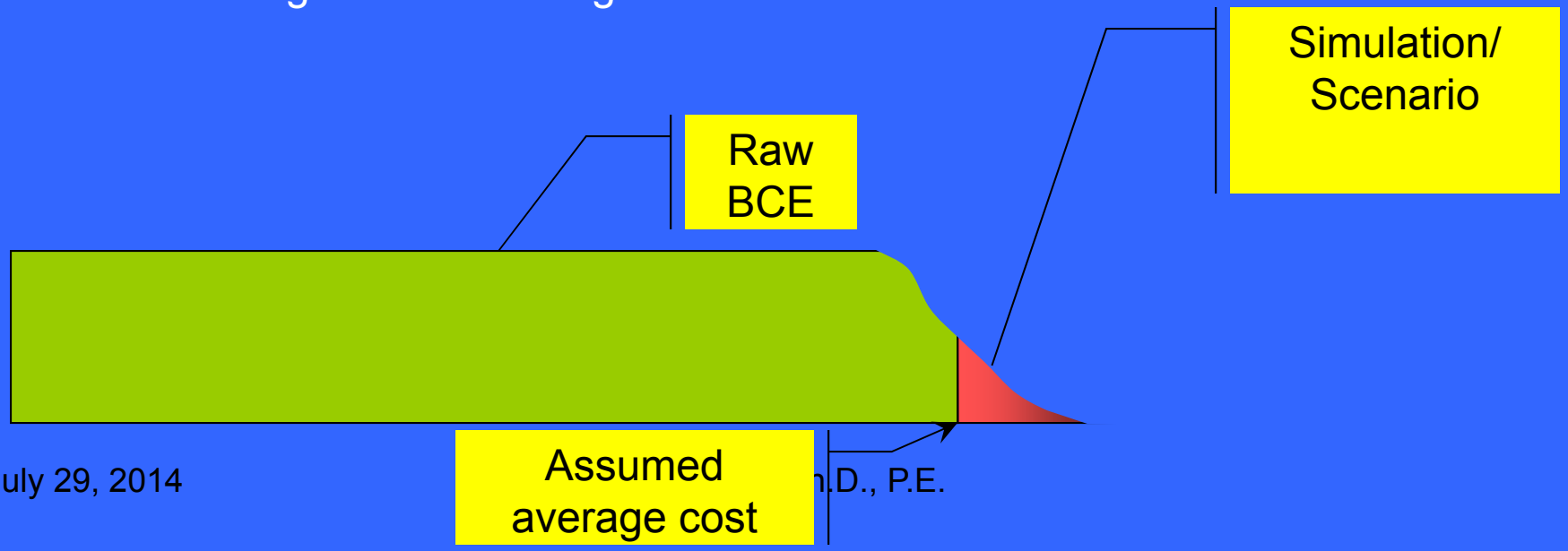
Risk assessment underlying concepts

- It would be helpful to recognize that contingency amounts included in estimates:
  - may (and will) vary in value, and
  - may vary at different rates
    (i.e., one risk item may require the full contingency amount, another may require only a small portion, and even another may require twice the estimated contingency).



PG-22 concepts

1. Make BCE as accurate as possible,;
2. Remove all contingencies from BCE, assume this is most likely cost
   - In practice, it may be difficult to remove all allocated contingencies;
3. Re-characterize the “risk” costs by:
   - Studying the project and identifying known risks (in a “Risk Register”); and
   - Modeling the risks through a simulation/ scenario



PG-22 concepts

	Measurable items	Unmeasurable items
Identified	Adjusted BCE	Risk Register

- Findings:
  - Identification of specific risks through risk register create too “narrow” of a variance
  - Focus on individual items and not project as a whole

PG-22 to PG-40 evolution

	Measurable items	Unmeasurable items
Identified	Adjusted BCE	Risk Register
Unidentified	Estimate gaps	Unknown risks

Add: Missing part by viewing the project as a whole, not as the addition of only identified parts.

Review of Cost and Bid Overruns on FFGA Projects

Presentation to Federal Transit Administration
April 26, 2006
Washington, D.C.

DAVID EVANS AND ASSOCIATES INC.

Agenda

- Study Objectives and Scope
- Grantee Explanations
- Escalation Trends
- Findings for Projects
- Conclusions
- Recommendations

Study Objectives

- Identify trends in causation of cost overruns on FTA funded construction contracts
- Suggest potential FTA policy responses to grantees seeking relief when confronted by significant cost overruns

Scope of Inquiry

- Five Projects with FFGAs and One Pending
  - Charlotte CATS LRT Project
  - Cleveland Euclid Corridor BRT
  - LA Metro Gold Line Eastside LRT Extension
  - Phoenix Valley Metro Rail LRT
  - Pittsburgh Port Authority North Shore LRT Extension (FFGA Pending)
  - Seattle Sound Transit Central Link LRT
- Cost increases post-FFGA or post-BCE

Grantee Explanations

- Limited Competition
- Excessive Cost Escalation
  - Steel
  - Concrete
  - Energy
- Market Effects of Natural Disasters

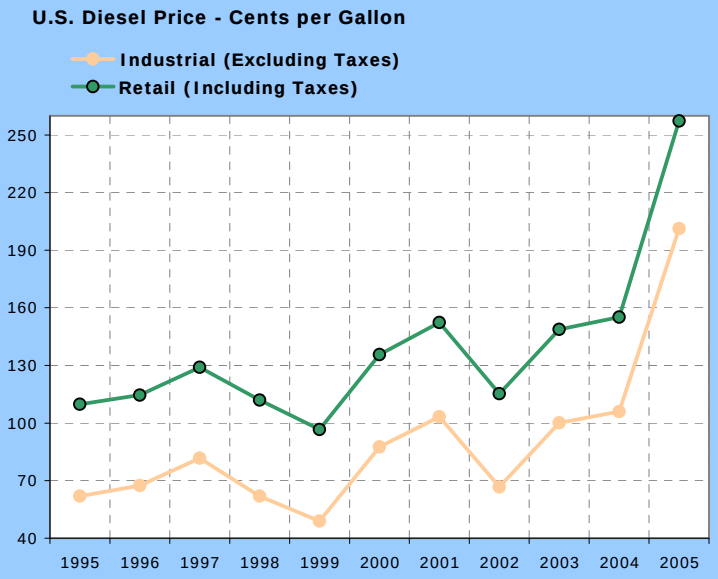
MATERIAL PRICES AND ESCALATION

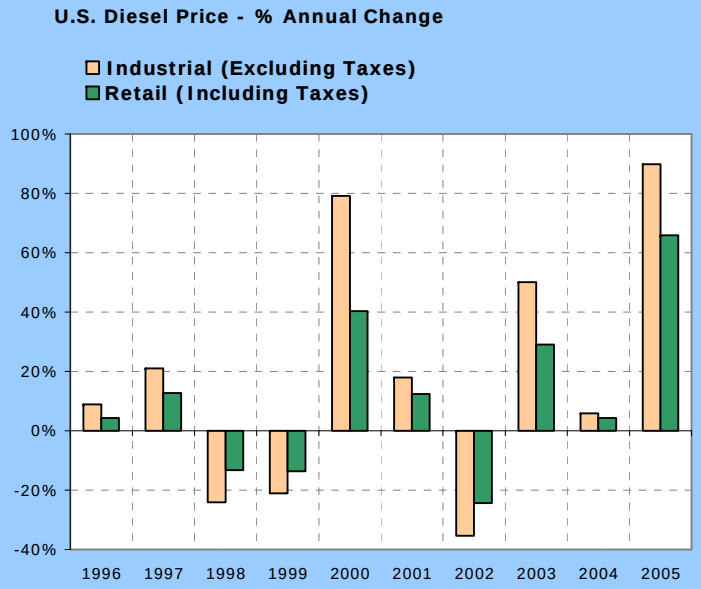
Highway Construction Cost History

	1998 - 99	1999 - 00	2000 - 01	2001 - 02	2002 - 03	2003 - 04	2004 - 05	% change 1998 - 2005
Highway & Street Construction	2.50%	7.80%	0.40%	-2.40%	2.20%	8.50%	12.60%	35.10%
Asphalt Felts & Coatings	-0.30%	4.90%	3.30%	3.20%	5.00%	1.30%	11.30%	31.90%
Cement	3.40%	-0.30%	0.10%	1.60%	-0.40%	3.00%	12.60%	20.90%
Concrete Block & Brick	2.70%	3.00%	2.40%	1.70%	2.00%	3.00%	8.90%	26.00%
Construction Machinery & Equipment Manufacturing	1.80%	1.10%	0.50%	1.40%	1.40%	3.20%	4.70%	14.80%
Construction Sand, Gravel & Crushed Stone	2.90%	3.80%	3.50%	2.50%	2.40%	3.50%	9.00%	30.80%
Iron & Steel Scrap	-15.60%	2.10%	-15.60%	17.80%	29.10%	76.80%	-9.90%	76.20%
Ready Mix Concrete	2.50%	2.70%	2.20%	-0.10%	0.40%	5.20%	12.20%	27.40%

Source: *ARTBA*

Diesel Fuel Escalation





U.S. Diesel Price	Average Annual Compound Growth, 2000 - 2005
Industrial	18.1%
Retail	13.7%

Industrial Fuel Prices:
Source: Energy Information Administration (EIA)

Retail Fuel Prices:
Source: Energy Information Administration (EIA)

U.S. Construction Escalation 2000 - 2005

Cost Category	Average Annual Increase in Price
Concrete[1]	3.7%
Steel[2]	17.9%
Other Materials[3]	6.7%
Construction Equipment[4]	0.0%
Right of Way[5]	8.0%
Skilled Labor[6]	4.1%

Sources: 1, 2, 3, 4. Bureau of Labor Statistics; 5. National Association of Realtors; 6. *Engineering News Record*

Weighted Average Inflation (2002- 5)

Charlotte	**6.5%**
Cleveland	3.2%
Los Angeles	**4.9%**
Phoenix	**5.8%**
Pittsburgh	2.9%
Seattle	3.0%
U.S. (2000-2005)	**4.1%**

Weighting factors: Skilled Labor – 56.6%, Right-of-way Acquisition – 9.4%, Equipment – 14.3%, Steel-9.2%, Concrete - 4.25, Other Materials - 6.4%

Source: HDR/HLB Decision Economics

Historic Cost Increases Versus Escalation Rates in BCEs

CITY	Average Inflation[1]	Apparent Escalation Rate in BCE[2]
Charlotte	6.5%	2.5%
Cleveland	3.2%	1.9%
Los Angeles	4.9%	3.2%
Phoenix	5.8%	6.0%
Pittsburgh	2.9%	5.4%
Seattle	3.0%	3.8%

Sources: 1. HDR/HLB Decision Economics; 2. David Evans and Associates, Inc.

Escalation Conclusions

- Average escalation somewhat higher than in the past
- Some grantees' BCE escalation rates were lower than actual rates in their region
- Volatility of prices for various construction items has been significant
- Contract pricing may have been affected more by volatility than average increases

PROJECT FINDINGS

Charlotte CATS Light Rail

- Light rail initial segment
- 9.6 miles total length
- 15 stations
- 7 park & ride lots
- 3.7 miles abandoned railroad ROW
- Revenue Operations Date: August 2007
- Total cost: $426.85 million (BCE)

Price History - Charlotte

Charlotte, NC

Annual Percentage Change						Average annual compound growth	
Cost Category	**2000 - 2001**	**2001 - 2002**	**2002 - 2003**	**2003 - 2004**	**2004 - 2005**	**Charlotte, NC**	**U.S.**
Concrete	0.3%	-0.2%	0.9%	7.4%	10.6%	**3.7%**	3.7%
Steel	-5.6%	4.0%	6.6%	33.0%	6.3%	**8.1%**	8.0%
Other Materials	-4.3%	-0.2%	4.6%	9.8%	0.6%	**2.0%**	2.7%
Equipment	N/A	N/A	N/A	N/A	N/A	**-**	0.0%
Right-of-Way	3.6%	2.6%	1.6%	10.9%	6.9%	**5.1%**	8.0%
Skilled Labor	14.6%	7.4%	12.9%	0.6%	N/A	**8.7%**	4.1%

Sources: Bureau of Labor Statistics, National Association of Realtors, RS Means

Findings – Charlotte

- CU-5 (Station Finishes) had greatest cost increase from BCE
- Bids due 2 weeks after Hurricane Katrina
- Single initial bid returned unopened per North Carolina statute

Findings – Charlotte (2)

- Re-bid attracted same single bidder
- Initial bid - $56.7 million
- Engineer's estimate - $28.1 million
- Independent Estimate - $36.1 million
- Award (after negotiation) - $44 million
- Major discrepancies in General Requirements item of General Conditions

Findings – Charlotte (3)

- General Requirements bid Item
- Contractor - $18.7 million
- Engineer's Estimate - $0.4 million
- Independent Estimate - $3.8 million
- Contractor stated: Short schedule and associated liquidated damages added $3 million

Findings – Charlotte (4)

- CU-4 Roadbed, Track and Structures
- Low bid 32% above engineer's estimate
- Major Variance in:
  - General Requirements
  - Retaining Walls
  - Bridges
- Retaining walls and bridges had both quantity and unit-price variances
- BAFO process used to reduce cost

Findings – Charlotte (5)

- Bids on CU-6 (Parking Garage) and CU-8 (Traction Power and OCS) were close to engineer's estimate

Cleveland Euclid Corridor BRT

- 9.4 mile bus rapid transit line
- 35 stations
- Significant urban design elements
- 20 articulated, low-floor vehicles
- Revenue operation date: December 2008
- Total cost: $168.4 million (BCE)

Price History - Cleveland

Cleveland, OH

Annual Percentage Change						Average annual compound growth	
Cost Category	**2000 - 2001**	**2001 - 2002**	**2002 - 2003**	**2003 - 2004**	**2004 - 2005**	**Cleveland, OH**	**U.S.**
Concrete	2.9%	0.7%	2.1%	8.1%	6.3%	**4.0%**	3.7%
Steel	-1.8%	-13.1%	0.9%	49.4%	8.0%	**6.8%**	8.0%
Other Materials	-0.3%	-1.3%	-2.5%	6.8%	-3.4%	**-0.2%**	2.7%
Equipment	N/A	N/A	N/A	N/A	N/A	**-**	0.0%
Right-of-Way	2.1%	2.0%	2.1%	2.0%	4.9%	**2.6%**	8.0%
Skilled Labor	9.1%	3.7%	-1.7%	4.7%	N/A	**3.9%**	4.1%

Sources: Bureau of Labor Statistics, National Association of Realtors, RS Means

Findings – Cleveland

- CO-3 Transit Roadway Construction had a significant cost increase over BCE
- Two bids - $29.2 mm and $28.1mm
- Engineer's Estimate - $17.6 million
- Bids rejected per Ohio statutes; >10% over Engineer's Estimate
- Engineer's estimate published with IFB per Ohio statutes

Findings – Cleveland (2)

- Contractor debriefing identified:
  - GCRTA considered tough owner with stringent documentation requirements
  - Paving design was not conducive to use of paving machines
  - Excessive requirements for QC, noise monitoring, traffic controls
  - Schedule requirements and related liquidated damages
  - Rising concrete and fuel costs

Findings – Cleveland (3)

GCRTA response following de-briefing:

- Develop action item list
- Workshop with Engineer, PMC, and DOT to review estimate issues
- Implemented most recommendations
- Re-bid resulted in low bid of $22.8mm vs. Engineer's Estimate of $21.7mm
- Low bidder did not bid in first round

LA Gold Line LRT Extension

- 5.9 mile light rail extension project
- 8 stations, 2 below grade
- 1 station modification
- Primarily at-grade with 1.7 mile tunnel
- Revenue operation date: July 2009
- Total cost: $898.81 million (BCE)

Price History – Los Angeles

Los Angeles, CA

Annual Percentage Change						Average annual compound growth	
Cost Category	**2000 - 2001**	**2001 - 2002**	**2002 - 2003**	**2003 - 2004**	**2004 - 2005**	**Los Angeles, CA**	**U.S.**
Concrete	2.9%	7.4%	3.1%	2.9%	3.2%	**3.9%**	3.7%
Steel	-1.8%	0.1%	-5.7%	17.4%	14.5%	**4.5%**	8.0%
Other Materials	-3.5%	3.3%	-4.4%	2.6%	11.2%	**1.7%**	2.7%
Equipment	N/A	N/A	N/A	N/A	N/A	**-**	0.0%
Right-of-Way	11.8%	20.1%	22.3%	25.9%	12.2%	**18.3%**	8.0%
Skilled Labor	3.5%	5.7%	4.8%	3.4%	N/A	**4.4%**	4.1%

Sources: Bureau of Labor Statistics, National Association of Realtors, RS Means

Findings - Los Angeles

- Two contracts were advertised with option to bid either or both combined
  - C-800 LRT tunnel (design-bid-build)
  - C-801 Surface alignment, stations and systems (design-build)
  - C-803 Combined C800 and C-801
- All bids substantially over BCE

Findings - Los Angeles (2)

- C-800 - Single bid 18.5% over budget
- C-801 – Two bids +46.8%, +33.6%
- C-803 – Two bids (different bidders) +21.3%, +34.1%
- LACMTA significantly reduced scope on C-801 to produce savings to fund C-800
- BAFO resulted in C-803 price of +13.3% over BCE

Findings - Los Angeles (3)

- General bid items (mobilization, general requirements) account for $110 million over engineer's estimate
- Dollar devaluation possible factor on German TBMs
- Material prices not a major factor in bid price differences from BCE

Findings - Los Angeles (4)

- Contract review comments
  - Extensive, broad General Requirements extending over 5 years
  - Front loaded payment for general requirements may not have provided adequate cash flow
  - Long contract duration (1,715 days) increases contractor's overhead
  - Unusual contract form (combined design-build and design-bid-build) increased risk

Findings - Los Angeles (5)

- Contract review comments (cont.)
  - Contractor's failure to timely submit "Time Impact Analysis" results in waiver of delay damages
  - Early return of submittals by Owner offsets Owner caused delays
  - Owner furnished documents for design-builder not warranted to be accurate and correct
  - Contractor liable for TBM performance despite Owner specifications

Phoenix Valley Metro LRT

- 19.6 mile Light rail initial segment
- 27 stations
- 7 park & ride lots
- 2 bridges
- Primarily at-grade in street median
- Revenue operations date: December 2008
- Total cost: $1.412 billion (BCE)

Price History - Phoenix

Phoenix, AZ

Annual Percentage Change						Average annual compound growth	
Cost Category	**2000 - 2001**	**2001 - 2002**	**2002 - 2003**	**2003 - 2004**	**2004 - 2005**	**Phoenix, AZ**	**U.S.**
Concrete	0.0%	1.2%	1.1%	4.5%	8.8%	**3.1%**	3.7%
Steel	-7.6%	4.0%	6.6%	34.1%	1.3%	**6.8%**	8.0%
Other Materials	-2.7%	0.4%	3.9%	11.3%	-0.4%	**2.4%**	2.7%
Equipment	N/A	N/A	N/A	N/A	N/A	**-**	0.0%
Right-of-Way	3.7%	3.2%	6.1%	11.1%	38.8%	**11.8%**	8.0%
Skilled Labor	7.0%	6.8%	7.1%	6.1%	N/A	**6.7%**	4.1%

Sources: Bureau of Labor Statistics, National Association of Realtors, RS Means

Findings - Phoenix

- Several contracts have experienced bids significantly higher than BCE
  - LS-3 $79.3 million vs. $64.0 million
  - LS-5 $68.9 million vs. $49.7 million
  - Station Finishes $52.7 million vs. $38.7million
- Local research confirms steel, energy and labor prices higher than forecast
- Local economy described as “robust”

Findings – Phoenix (2)

- Escalation rates used to forecast the year of expenditure (YOE) budget were less than actual
- High price for Station Finishes likely affected by contract requirement for simultaneous completion of 27 stations
- Other contracts appear reasonably sized based on geographic limits

Findings – Phoenix (3)

- Five contracts contained Concurrent Non-Project Activities (CNPA); work not directly associated with the LRT project that is locally funded
- CNPA is identified separately on bid forms
- All 5 contracts showed price differentials (budget vs. bid) were higher for FTA funded work than locally funded work

Pittsburgh North Shore Connector

- 1.2 miles light rail extension project
- 2 new stations (1 underground)
- 1 reconfigured underground station
- Cut / cover & bored tunnel (under river) plus at-grade
- Revenue operation date: 2010
- Total cost $393 million BCE

Price History - Pittsburgh

Pittsburgh, PA

Annual Percentage Change						Average annual compound growth	
Cost Category	**2000 - 2001**	**2001 - 2002**	**2002 - 2003**	**2003 - 2004**	**2004 - 2005**	**Pittsburgh, PA**	**U.S.**
Concrete	22.3%	-1.2%	3.6%	-12.6%	13.8%	**4.5%**	3.7%
Steel	-1.8%	0.0%	-5.0%	18.2%	15.5%	**5.0%**	8.0%
Other Materials	3.8%	-2.7%	17.2%	42.8%	20.9%	**15.4%**	2.7%
Equipment	N/A	N/A	N/A	N/A	N/A	**-**	0.0%
Right-of-Way	4.4%	3.7%	5.7%	4.8%	2.1%	**4.2%**	8.0%
Skilled Labor	7.9%	-4.4%	1.6%	1.7%	N/A	**1.6%**	4.1%

Sources: Bureau of Labor Statistics, National Association of Realtors, RS Means

Findings - Pittsburgh

- Project has FFGA pending
- Project costs increased by approximately $30 million during final design phase
- Increases occurred despite a pre-final design risk assessment and implementation of risk mitigation measures

Findings – Pittsburgh (2)

- North Shore Tunnel Contract (NSC-003) was major focus
- Engineer's estimate - $70.5 million

  (Estimate included an increase in the construction cost index due to higher than anticipated prices in 2005 (7.8% v. 3.5%))
- Low bid (non-responsive): + 24.6%
- Second low bid: +60% ($112.9mm)
- All bids rejected

Findings – Pittsburgh (3)

- Contractor debriefings indicated:
  - Contractual terms and conditions caused unreasonable risk shifting
  - Lack of a differing site conditions clause
  - Lack of a Geotechnical Baseline Report
  - Uncertainty over project funding
  - Fluctuation in Canadian exchange rate increased TBM costs
- Lack of competition suggested but three bids on tunnel is not unusual.

Findings – Pittsburgh (4)

PAAC response following de-briefing:

- Adopted cost reduction options expected to save $90 million
- Incorporated changes to contract terms and conditions
- Prepared and issued a Geotechnical Baseline Report
- Incorporated 9 contractor suggested cost reduction changes

Findings – Pittsburgh (5)

- Re-bid NSC-003 with option for NSC-006 (cut & cover tunnel)
- 5 bids received; all exceed engineers estimate:

Contract	Base Cost	Contingency	Escalation	Total BCE
NSC-003	$75,163,138	$3,927,742	$12,498,523	$91,589,403
NSC-006	$42,500,000	$2,125,000	$6,411,709	$51,036,709
Total	$117,663,138	$6,052,742	$18,910,232	**$142,626,112**

#	Bidder Name	NSC-003	NSC-006	NSC-003/006
1	Kenny Construction Co.	$106,457,029	n/a	n/a
2	Walsh/Traylor/Shea (JV)	n/a	n/a	$163,210,055
3	North Shore Constructors (JV)	$105,800,000	**$59,800,000**	**$156,500,000**
4	Brayman	n/a	$59,889,430	n/a
5	Jay Dee/Brayman (JV)	**$99,692,623**	n/a	$158,165,605

Findings – Pittsburgh (6)

- Re-bid attracted more bidders (5 vs. 3)
- Bids generally tighter than first round
- Joint award of both contracts saved money compared to separate awards
- Division 1 prices down for NSC-003
- Division 3 prices up for NSC-003
  - TBM price >> Engineer's Estimate
  - TBM Mob and De-mob >> Engineer's Estimate
  - Bored Tunnel>> Engineer's Estimate

Findings – Pittsburgh (7)

- NSC-006 (Cut & Cover Tunnel) Results
  - Div 2 >> Engineer's Estimate
  - Most of variance in Support of Excavation
- Re-bid prices reflect current value of work in the marketplace
- Contractor prices appear to reflect lower risk Change Orders due to tighter specs

Seattle Central Link Light Rail

- 13.9 mile light rail initial segment
- 7 stations + 4 renovated bus tunnel stations
- 1 mile Beacon Hill tunnel
- 1.3 mile downtown bus tunnel renovation
- At-grade and elevated segments
- Revenue operation date: July 2009
- Total cost: $2.437 billion (BCE)

Price History - Seattle

Seattle, WA

Annual Percentage Change						Average annual compound growth	
Cost Category	**2000 - 2001**	**2001 - 2002**	**2002 - 2003**	**2003 - 2004**	**2004 - 2005**	**Seattle, WA**	**U.S.**
Concrete	10.8%	2.8%	0.5%	2.2%	1.2%	**3.4%**	3.7%
Steel	-1.8%	-37.2%	0.0%	21.8%	17.9%	**-2.4%**	8.0%
Other Materials	-6.0%	2.9%	3.0%	14.1%	6.7%	**3.9%**	2.7%
Equipment	N/A	N/A	N/A	N/A	N/A	**-**	0.0%
Right-of-Way	11.9%	3.4%	4.2%	19.0%	8.5%	**9.3%**	8.0%
Skilled Labor	0.5%	4.8%	5.9%	2.4%	N/A	**3.4%**	4.1%

Sources: Bureau of Labor Statistics, National Association of Realtors, RS Means

Findings - Seattle

- C-710 Beacon Hill Tunnel major focus
- Engineer's estimate - $239 million
- 4 contractors submitted qualifications
- 3 contractors were pre-qualified
- Two bids received: +17.2%, +27.6%
- Low bid: $280 million

Findings – Seattle (2)

- Grantee took reasonable steps to define the geotechnical conditions
- Contract documents are complete and comprehensive
- No evidence of significant risk shifting
- Station excavation spec very prescriptive
- Contractor has encountered unexpected ground conditions despite prior extensive geotechnical investigations

Findings – Seattle (3)

Quantitative bid analysis

Low Bid: 6 bid items > 500% (highest 1875%) of Estimate
9 bid items 300% - 499% of Estimate
48 bid items 101% - 299% of Estimate

High Bid: 11 bid items > 500% (highest 3846%) of Estimate
10 bid items 300% to 499% of Estimate
36 bid items 101% to 299% of Estimate

Average: 8 bid items > 500% (largest 2187%) of Estimate
11 bid items 300% - 499% of Estimate
41 bid items 101% - 299% of Estimate

Findings – Seattle (4)

ITEM	UNITS	ENG EST	LOW BID
Temp Traffic Control	LS	$193k	$1.4M
Instrumentation	LS	$1.056M	$2.4M
HVAC Tunnels	LS	$1.238M	$3.5M
Slurry Wall Main Shaft	LS	$4.225M	$6.5M
Barrel Vaulted Pipe Arch	LF/Total	$88/ $560k	$235 / $1.494M
Shotcrete	SF-in./ Total	$.80 / $7,776	$15 / $1.458M
Chemical Grout	Gal	$20 / $444k	$70 / $1.555M

GENERAL FINDINGS

General Findings

- Grantees must pay closer attention to escalation rates and YOE calculations than in recent years
- Contract terms and conditions have had a strong influence on contractor pricing in some cases
- General Requirements costs has been a source of significant variances

General Findings (2)

- Grantees claim that pricing adversely affected by external factors such as rapidly increasing prices for construction materials, energy, and labor, including effects of natural disasters
- Material prices, while somewhat volatile, were not as great a driver as expected
- Grantee estimates should reflect local construction markets

General Findings (3)

- Pricing may be adversely affected by lack of competition, perhaps resulting from procurement strategies or contracting practices
- Extensive use of lump sum pricing makes meaningful bid analysis very difficult

RECOMMENDATIONS

Recommendations

1. Local Market Conditions Analysis
2. Update Cost Databases
3. Increased Attention to Escalation
4. Constructability Reviews
5. Contract Packaging Strategy
6. Industry Review of Contract Provisions
7. Implement LMRO Construction Phase Recommendations

Recommendations

1. Local Market Conditions Analysis

- Assess local construction market during PE; update during final design
- Capabilities of local contractors and capacity to perform work of certain dollar value (usually based on bonding capacity)
- Identify other major construction projects
- Incorporate results into the procurement strategy developed by the grantee.

Recommendations

2. Update Cost Databases

- Require design consultants to update their construction cost databases with current local prices for key commodities before developing Engineer's Estimates.
- Begin during PE phase
- Verify data locally if rates taken from published national sources, e.g., RS Means, Dodge

Recommendations

3. Increased Attention to Escalation

- Recent moderate escalation unlikely to continue
- Booming construction market a factor in escalating overall contract costs
- Consider a range of escalation rates in YOE calculations
- Explicit consideration of escalation rates during risk assessments

Recommendations

4. Constructability Reviews

- Undertake constructability reviews beginning with the PE phase.
- Initial review as input to developing an appropriate contracting strategy
- Identify critical factors for consideration during the final design phase.

Recommendations

5. Contract Packaging Strategy

- Develop as part of PMP during PE
- Identify number and type of construction contracts (construct only, design-build, CM-GC, etc.)
- Number and type of procurements
- Strategy guides final design process
- Determine approximate dollar values as input to local market assessment

Recommendations

6. Industry Review of Contract Provisions

- Transit peer review of General and Special Conditions and Division 1 Specs
- Identify areas of contractual risk shifting
- Understand consequences of risk shifting
- Review by local / transit contractors
- Critical for first time New Start grantees
- Hand me down contracts need review by local construction attorney

Recommendations

7. Implement Construction Phase Recommendations (Spot Report No. 78 (D), FTA Oversight of LMRO Major Capital Projects during Construction)

- Review of construction phase PMPs
- Contract packaging and procurement strategies,
- Substantive review of construction contracts
- Prior to approval of an FFGA

PITTSBURGH BCE ADJUSTMENT

Pittsburgh BCE Adjustment

- Material Price Escalation (Total Project)
  - Steel products - $5.7 million
  - Concrete Products - $4.6 million
  - Fuel for Construction Equipment - $3.7 million
- $14 million increase from BCE
- 50% of increase attributed to NSC-3 & 6

Pittsburgh BCE Adjustment

- Increase in Cost of Owner Controlled Insurance Program - $4 million
- Re-bid NSC-3 & 6 - $21 million
  - Includes Material Price Escalation - $7 million
  - Remaining Increase Attributed to Market Conditions - $14 million

Pittsburgh BCE Adjustment

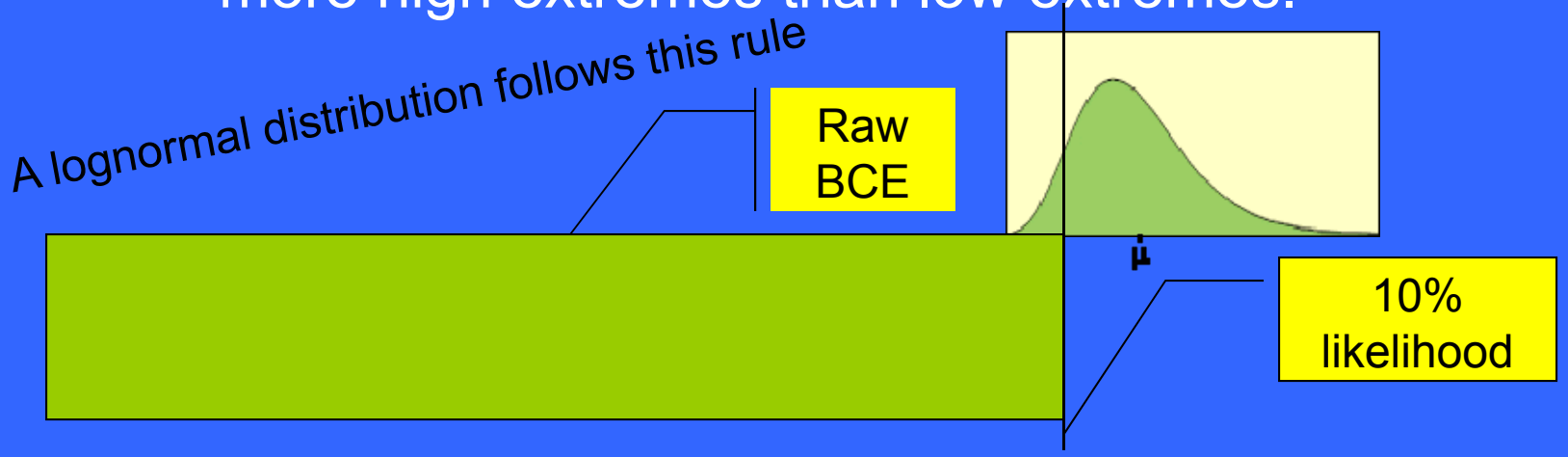
- Material Prices: + $14 million
- Increased OCIP: + $4 million
- Construction Market Increase: + $14 million

BCE increased by $32 million

DISCUSSION

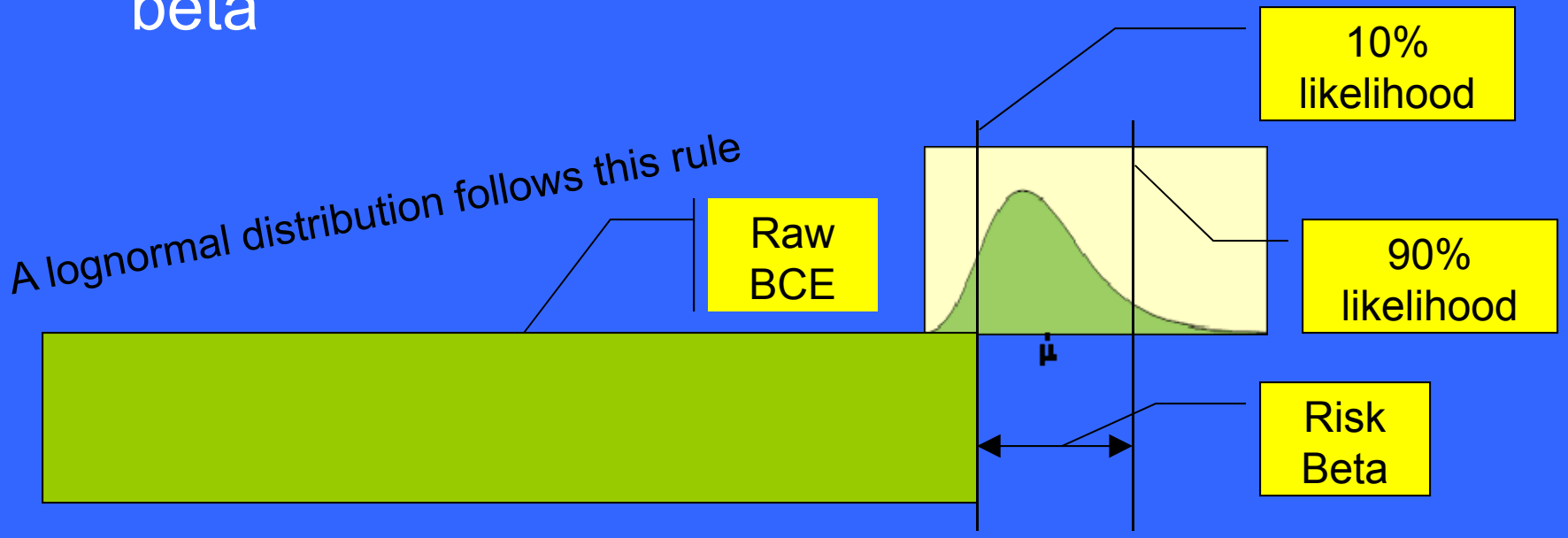
PG-40 concepts

- A couple of basic assumptions:
  1. The raw BCE is typically optimistic and there's only about a 10% chance of under-running the raw BCE; and
  2. Final pricing on a particular item will tend toward more high extremes than low extremes.



PG-40 concepts

- Historic spreads between 10% likely and 90% likely values vary among phases.
- This spread (10% to 90%) is called the “risk beta



PG-22:

Narrower spread (Beta)
Lower expected values